A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

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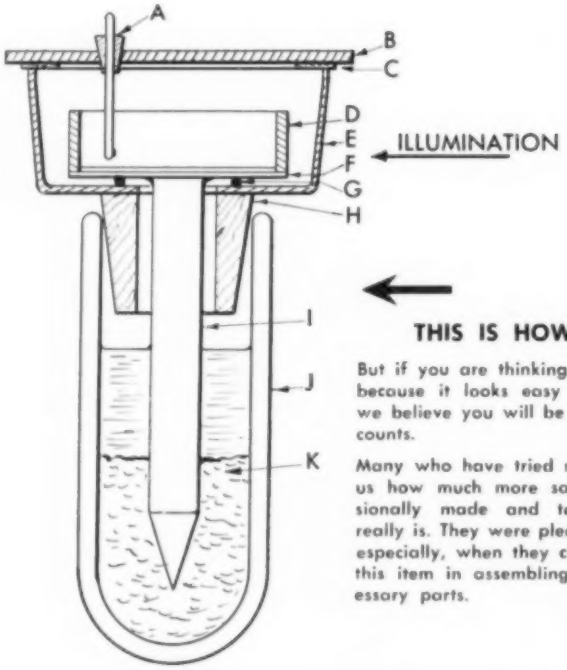

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The Conservation Concept—Its Significance for a Free Society

By Francis X. Kleyle, School of Education, Duquesne University, Pittsburgh, Penna.

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Special Molecular Models as an Introduction to the Geneva Nomenclature

By Mary Jo Lefere and George Brewer, Marygrove College, Detroit, Michigan.

Why Not Semimicro?

• **By Sister Ernestine Marie O'Connell, S.C.H., M.Ed.,** *(Boston University)*
SAINT PATRICK'S CONVENT, QUEBEC, CANADA

Semimicro methods are widely used in college qualitative analysis and they are coming into greater use in organic chemistry. Freshman chemistry and high school chemistry courses seem to be slow in adopting this proven technique.

There are very few high school experiments that can not be performed by semimicro techniques.

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With time, money, storage space and safety at a premium, why are so many teachers loathe to abandon the macro techniques of yesteryear in favor of the semimicro experimentation of today? Perhaps it is fear of the unfamiliar; perhaps it is the mistaken notion that a complete and expensive laboratory conversion is necessary. It is hoped that this article will dispel some of these fears and encourage more teachers to switch over to a method they will not want to discard once they try it.

Exactly what is meant by the semimicro technique? Small scale experimentation, well within the range of visibility and not requiring microscopic investigation of reactions. Generally speaking, a ten ml. test tube is the basic piece of glassware, and experiments involving liquids employ one or two milliliters of the substance to be tested, with the reagent added dropwise until evidence of reaction occurs. What is the advantage? In number one place is the obvious safety margin. When students have only a milliliter or two of solution in their hands, even explosions are of minor significance, and damage to person, property and clothing is minimal. Much greater freedom of experimentation can be tolerated as the teacher has the added confidence that serious injury is most unlikely. Students may be allowed to test their ideas rather than merely follow cook-book laboratory manuals and can then learn chemistry scientifically from a problem-solving approach.[1]

In the second place, time for experimentation is tremendously cut. In our modern high school curriculum in which double chemistry laboratory period offers great difficulties to those who plan the horarium, semimicro can solve the problem most efficiently. Even though a double period is often desirable, or at least a period which can be prolonged after the bell if necessary, semimicro technique makes it possible to perform the ordinary high school experiments within forty-five minutes. Small quantities cut reaction time; small amounts are quickly heated; small volumes are easily evaporated. Four ten-milliliter vials of gas are readily and easily collected, whereas the bubble-free inversion of four eight-ounce gas collecting bottles in a pneumatic trough takes many a pupil the entire laboratory period! In SM, either old litmus paper vials or ten milliliter test tubes are merely tossed into a pneumatic trough and fill themselves in a bubbleless fashion. As needed, they are slipped over the delivery tube, filled with gas, and corked under water. This obviates the confusion of glass plates for the insertion and removal of bottles of gas, and also insures safety of the collected gas until such time as the pupil is ready to use it.

Small storage space and low cost are other great advantages. Individual student equipment may be as little as the following:

10—10 ml. test tubes, corks and stoppers
1—pneumatic trough
1—micro or Bunsen burner, stand, gauze
1—crucible and cover
1—wash bottle (Florence flask with tubes)
1—ampoule cutter or file
1—test tube holder
1—watch glass
2—droppers
glass tubing and rodding

To these might be added horn-pan balances, weights, forceps, cobalt glass, burettes, small beakers and Erlenmeyers, but they are used so occasionally that a few in stock is sufficient. The 10 milliliter test tubes are much cheaper that the 25 or 50 ml. variety—and they are harder to break too! The thistle tubes are out, and with them go innumerable headaches over tubes breaking in pupils' hands. Erlenmeyer, round-bottom, Florence flasks and beakers of the 125 ml. volume are seldom used, hence, rarely broken. Student apparatus can be stored in a small drawer or box. Macro apparatus on hand can be used up gradually and replaced by smaller vessels. Annual replacement costs for a class of fifty may run as low as five dollars for glassware and not over twenty for chemicals, the latter depending, of course, on the stock on hand. A one-pound bottle of $KClO_3$ has lasted my class of forty-five for ten years now!

Must much extra equipment be bought? A centrifuge is the only suggestion and a fine four-tube one costs as little as thirty-five dollars. Hand rotated ones are still cheaper. If speed is not a factor in changing to SM, even the centrifuge may be omitted, as precipitates settle in a matter of minutes anyway. Horn-pan balances and weights are excellent for individual experiments of a quantitative nature. The analytical balance is an extravagance beyond the reach of most of us and is not essential for regular high school "research."

The idea of individual dropping bottles of liquid reagents and a rack of small bottles of solids for every pupil is not to be advocated at the secondary level as

(Continued on Page 24)

[1] Marie, Sister Ernestine, "Inductive Teaching at the Secondary Level," *Journal of Chemical Education*, 35, 46 (1958).

The Use of Spectral Absorption in Chemistry and Biology

• **By Sister Miriam Michael Stimson, O.P., Ph.D.,** *(Institutum Divi Thomae)*
DIVISION OF NATURAL SCIENCE, SIENA HEIGHTS COLLEGE, ADRIAN, MICHIGAN

Modern instrumentation has made possible an increased use of spectral analysis in the biological and chemical sciences. The progressive chemistry or biology teacher will find this article most informative.

This paper was presented at the Mount Mercy College High School Chemistry Teacher Institute in the spring of 1958.

●

A proper appreciation of the tool for spectral absorption and its uses leads to a vivid realization of the interplay among the contributions of the various disciplines of science, and the fact that at every step of the interplay the scientist had to display imagination and creativity as well as the more generally recognized curiosity. It was Newton who formed the first spectrum but it was not until almost 150 years later that Wollaston incorporated the essential elements of a modern instrument (a lens between source and prism and a narrow slit) and began to examine his world with the instrument, and it was almost another 50 years later that a team made of a physicist and a chemist identified two new elements by their spectra. At the beginning of the present century under the genius of the French chemist, Victor Henri, the photographic method of measuring the amount of absorption was developed and extensively applied to organic compounds. Since the development of quantitative methods and the refinement of measurements by the now standard spectrophotometers, attention was turned to the measurement and elucidation of the electron cloud or "glue" of the molecule. Next, attention became more widely focused on the vibrational and rotational properties of molecules. Commercial instrumentation in this field became a reality at the end of the Second World War and thus paved the way for widespread study on the research level of the infrared characteristics of many compounds. The development within the last two years of laboratory bench models of infrared spectrophotometers will extend the application of this type of examination and it is a necessity for the progressive science teacher to have some notion of the types of information which can be gained through ultraviolet and infrared spectrophotometry. In the SCIENCE COUNSELOR for September 1953 an electronic spectrum was included to illustrate the central theme of the discussion, and in the SCIENCE COUNSELOR for March 1954 a plate of infrared spectra was included. Future trends point to the inclusion of more of such types of data and it is hoped that they will be made more meaningful by the discussion in this article.

Spectroscopy is concerned with interactions between matter and electromagnetic radiation (light) in which energy is abstracted from or added to the radiation field. The chemist's or biologist's interest is in the application of spectral data to the acquisition of information on the type or amount of a compound present. The spectra represent the response of the chemical under investigation to a progressive series of test questions of changing probing ability. In a crude analogy the situation of the chemical might be compared to that of a man confronted with a series of preference items: soups (bean, chicken, onion, pea, tomato, vegetable), salads, etc. The set of questions tests his appetite for foods, but he has other types of appetites which might also be tested for by asking his preferences in sports, or music. In each case it is the same man under consideration and we can eventually form some impression as to the type of a man.

In the case of the chemical the sets of questions are asked of the nature of the electronic distribution, particularly of the valence electrons, and of the motion of the atomic nuclei being held by chemical bonds. Every chemical will respond to the proper question asked of these two properties, but if we can judge a man's appetite-preference by the food he selects, we must put before him the possibility of something he would eat. Live snails may be a delicacy in some parts of the world but would not be frequently chosen in an American cafeteria. So too, the range of electromagnetic radiation put before a chemical must be that to which the chemical can make a selective response. In general the range for reactivity based on the electron cloud will be in the visible and ultraviolet parts of the spectrum and for the motion of the atomic nuclei will be the infrared region. Just as a man will show one set of preferences for the soup menu and another for salads or meats, since it is the same man making the choice in both cases, we will not be surprised to find that the qualities that influence one choice will also be reflected in the other. We can thus expect that although the density and mobility of the electron cloud will be seen primarily in the electronic spectrum found in the uv and/or visible range, it will also have some influence on the pattern of the infrared spectrum due to the motion of the atomic nuclei.

We will now attempt to examine some chemicals familiar to the high school teacher with respect to their spectra.

Electronic spectra:

Chemicals are frequently considered rather arbitrarily as inorganic and organic and among neither of these classes of chemicals is *color*, a common property. The origin of color is the interaction of electromagnetic

radiation in the visible region of the spectrum with the particular chemical. The energy associated with the visible spectrum is less than that associated with the ultraviolet spectrum. In terms of the reaction of radiation with the electron cloud it is thus seen that for some molecules the energy required to disturb the cloud must be greater than for others. The differences seen in the electronic spectrum should be able to be interpreted in the chemical sense. Thus, tetrammine-copper (II) nitrate is stable under the conditions of being ground with very fine potassium bromide powder. Under the same conditions, however, cupric nitrate trihydrate undergoes decomposition to form the oxide. Examination of the visible spectrum in Figure 1 shows that the tetrammine complex has the absorption maximum of 600 m_μ (thus absorbing or blotting out that part of the spectrum which is the region that gives the characteristic color to a sodium flame), whereas the hydrated copper (II) ion has its electronic absorption maximum at 800 m_μ. In terms of energy we might consider that whereas the tetrammine ion can accommodate a packet of about 2.0 electron volts the hydrated copper ion can accommodate a packet size of only about 1.5 electron volts. The greater stability of the tetrammine ion is, of course, indicated by the fact that it can be prepared by the addition of ammonium hydroxide to an aqueous solution of the copper ion, in which reaction the ammonia molecules displace four of the water molecules coordinated to the central copper ion. A practical application of the absorption of energy is found in the use of dilute solutions of copper sulfate as heat filters in microscopic work, particularly when living materials are being examined. The absorption maximum lies in the infrared region (or heat region of the spectrum) and thus while the solution is a good heat absorber it will not greatly cut down the amount of visible radiation used as the light source for the optics of the microscope.

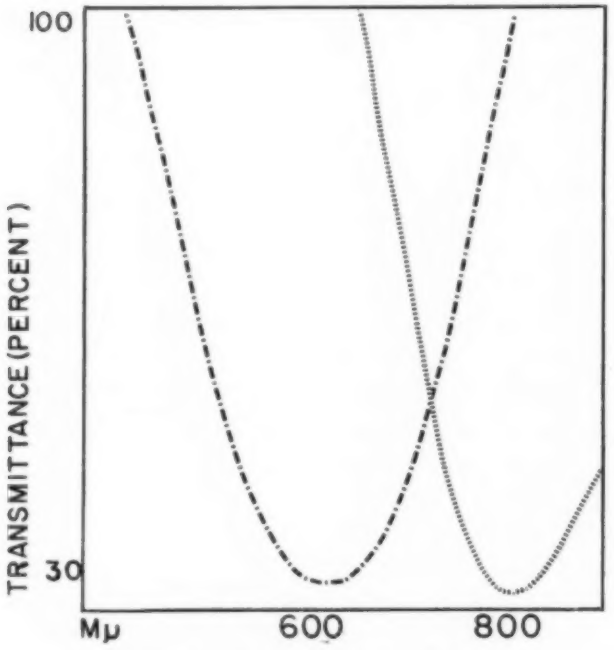


FIGURE 1. Visible Absorption Spectra of Complex Copper (II) Ions

The ordinate of Figure 1 is % transmittance. It represents a comparison between the transmittance of the solvent and of an equal path length of the solution. The idea implied is that the absorption due to the solvent will thus be compensated and the presented transmittance will be that of the solute. While this is generally the case, it is sometimes misinterpreted to mean that there is no interaction between the solvent and the solute. Particularly when the solvent is a highly polar substance such as water there will be at least orientation of the solvent molecules with respect to the solute, and whereas the orientation may not be apparent in the properties of the solvent it is frequently reflected in the behavior of the solute. The abscissa represents wavelength of the radiation used to test the substance, and the long wavelength end is at the right side of the diagram and the successively shorter wavelength (or higher energy) radiation appears to the left. The wavelength for the visible and ultraviolet ranges of the spectrum are generally given in millicrons (m_μ). 1 m_μ is the equivalent of 10^{-7} cm. In the infrared region the quality of the radiation may be expressed in microns (1 μ is 10^{-4} cm) or in wavenumber. Wavenumber indicates the number of waves per cm and is thus expressed in terms of cm^{-1}. Strong partisans exist for the use of wavelength and for wavenumber as a uniform mode of expression. No one system of plotting the data has been adopted because of the inadequacy of any one system over the entire spectral range.

Vibrational spectra:

Figure 2 represents an infrared spectrum of a single large crystal of $CuSO_4 \cdot 5HOH$ in which the abscissa represents the wavelength in microns. Figure 3 represents the infrared spectrum of tetrammine copper (II) nitrate which was examined pressed into a disk in potassium bromide. Whereas both visible spectra for the respective compounds were obtained in aqueous solution, the same specimens could not be measured in the infrared due to the fact that in the region investigated water is highly absorbing. (Relate this to your own experience that in only a very short depth below the surface of a lake, the heat from the sun is almost completely filtered out.) If infrared absorption is considered in terms of the mechanical motion of the constituent atoms joined by covalent bonds in a compound, then the energy absorbed by the water molecules would be used in stretching and bending the hydrogen atoms of the molecule with respect to the oxygen atom. Since so much larger a portion of a solution is the solvent than is the solute the infrared spectrum obtained would be primarily that of the solvent—which is just the reverse of the situation which obtains for the electronic region of the spectrum.

If one makes use of the idea that it is those atoms held by a covalent bond that react to infrared radiation, then there will be two simple methods whereby

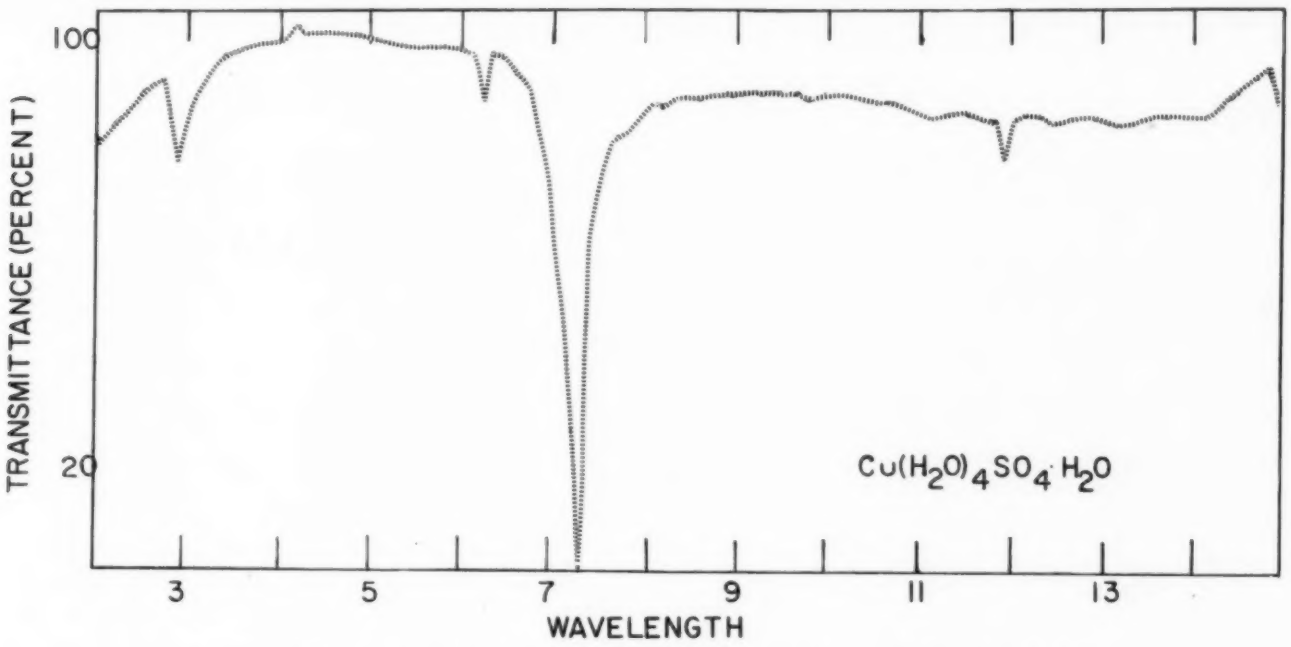
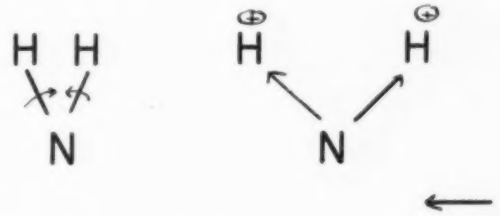


FIGURE 2. Infrared Absorption Spectrum of Single Crystal of Copper Sulfate Pentahydrate.

one can "see" the solute: (1) Use a single crystal of the solute and thus eliminate the solvent completely; (2) Use a substance that is completely ionic for the solvent. This is the idea behind the potassium bromide disk method of diluting the solute. Figure 2 is of a chemical involving a single crystal, and Figure 3 was obtained using the potassium bromide disk method. Both spectra are relatively simple and certain correlations can be made between the spectrum and the respective compound. Figure 2 shows two more obvious bands, at 2.90 and 7.34 μ and two less conspicuous bands at 6.26 and 11.92 μ. It was rather surprising to find such a strong sharp band at 7.34 μ rather than a broad band between 8 and 9 μ as was reported by Miller and Wilkens for the anhydrous copper sulfate. However, there is another surprise in the spectrum shown in Figure 2 and that is the almost negligible absorption near 3 μ which should represent the H—O stretching of the water of hydration. Since there are five moles of water for each copper sulfate, one would expect that this would be a very strong absorption, indeed. This rather unusual infrared spectrum is a very nice one to indicate how one can learn something of the structure of molecules from their spectra. This is essentially the method used with much more complicated spectra and more complicated molecules, both organic and inorganic.

The only feature in Figure 2 which is common to the pentahydrate and the commercial anhydrous form is the very slight absorption at 6.26 μ—thus we might attribute this to $SO^{-}{}_{4}$, since only in this fraction of the molecule are there covalent bonds existing in both types of sample. The sharp absorption at 7.34 μ (1364 cm^{-1}) is reasonably close to the position of absorption frequently found for covalent sulfate. This would seem to indicate that we must more carefully reconsider a representation of copper sulfate pentahydrate in the solid state. An octahedral coordination of the copper atom which involves 4 oxygen atoms of 4 of the water molecules and 2 oxygen atoms of sulfate ions would account for the similarity in the band position found for this compound and that found for covalent sulfates. Moreover, hydrogen bonding involving the fifth water molecule, the sulfate group and the hydrogen atoms of the ligand water molecules would account for the weakness of the H—O band at 3 μ as well as for the sharpness of the absorption.

In Figure 3 is shown the infrared absorption of $Cu(NH_3)_4(NO_3)_2$. The spectrum in this case is straight forward. The absorption at 2.9 μ is attributed to N—H stretching, that at 5.09 (1642 cm^{-1}) and at 8.03 (1245 cm^{-1}) to N—H bending vibrations. These bending vibrations may be represented as



respectively. The nitrate ion absorbs as an entity at 7.25 μ (1380 cm^{-1}), 12.17 μ (822 cm^{-1}) and at 14.45 μ (692 cm^{-1}) and these positions are in good agreement with the values given by Miller and Wilkens for various inorganic nitrates.

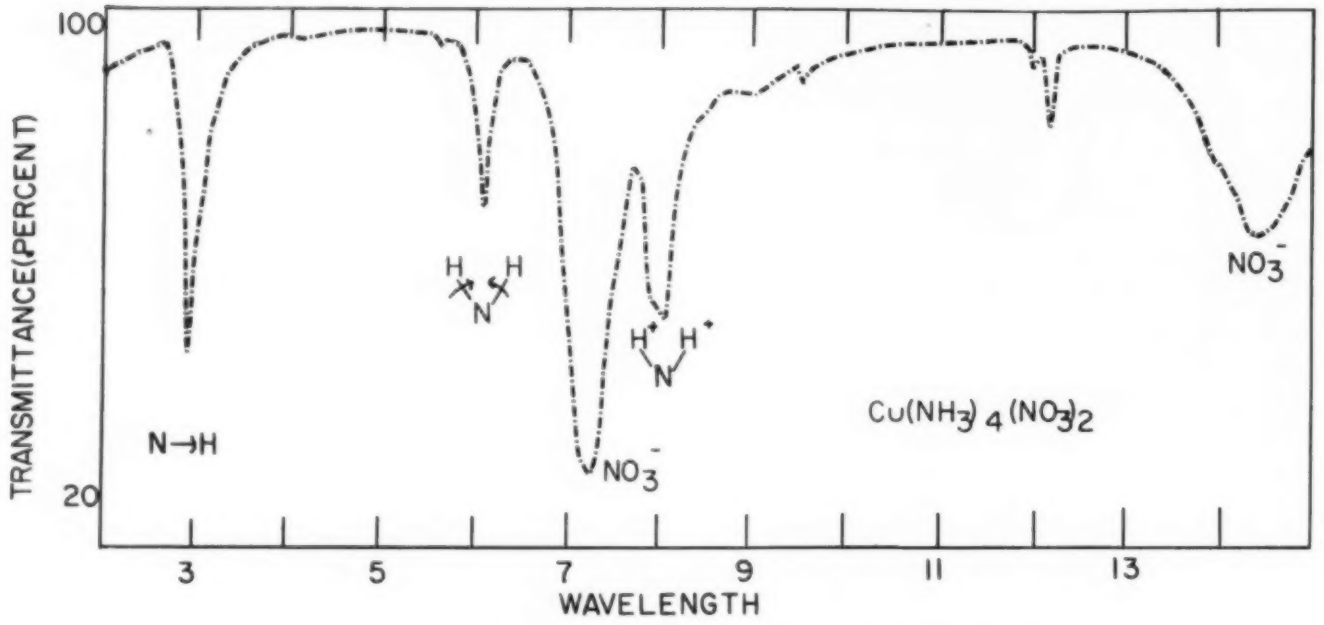


FIGURE 3. Infrared Absorption Spectrum of Tetrammine Copper (II) Nitrate.

In Figure 4 is shown the infrared spectrum of $Cu(NH_3)_4(SO_4)\cdot H_2O$. Here the features indicative of the N—H vibrations appear, but they are slightly displaced. The most striking difference between this spectrum and either of that shown in Figures 2 or 3 is the appearance of a strong absorption band for the sulfate ion. A direct comparison with the spectrum of the tetrammine copper (II) nitrate would indicate that the assignment of the 7.25 μ band must be related to the NO_3 ion since it is missing in the coordination compound which involves the sulfate. It will also be noted that the absorption in the 3 μ region is considerably stronger in the case of the latter compound. This might be interpreted as indicating that the water molecule, which corresponds with the fifth water molecule of the pentahydrate, is more loosely held and hence permits both itself and the sulfate ion to be revealed. *(Continued on Page 30)*

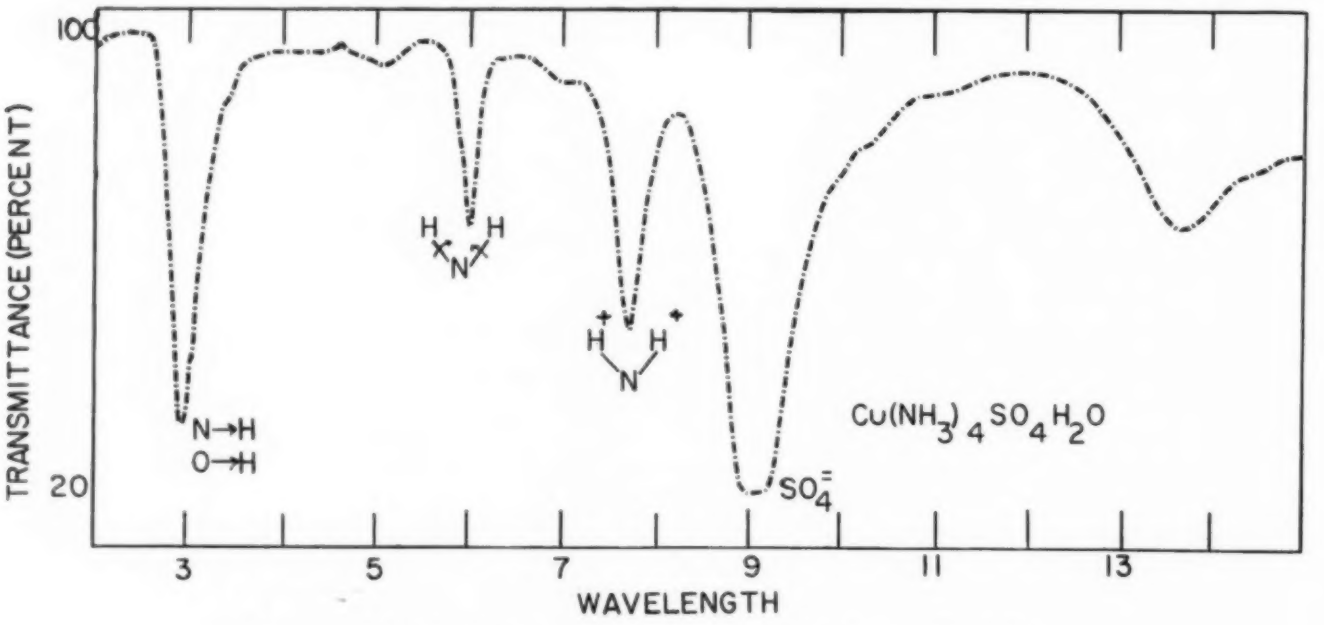


FIGURE 4. Infrared Absorption Spectrum of Tetrammine Copper (II) Sulfate.

Pontificia Academia Scientarum

The Pontifical Academy of Sciences

• **By Sister Mary Martinette, B.V.M., Ph.D.,** *(University of Illinois)*
DEPARTMENT OF CHEMISTRY, MUNDELEIN COLLEGE

Sister Mary Lois, B.V.M.
THE SCHOLASTICATE, SISTERS OF CHARITY, B.V.M.

"FAITH DOES NOT FEAR REASON: dogma is not afraid of scientific research. No indeed, the church, friend and champion of all truth, clamps no chains on freedom honestly seeking to discover the truth still hidden in nature's secrets."

Pope Pius XII to a group of American Fulbright Scholars.

●

As we look back over the remarkable reign of Our Holy Father Pope Pius XII we are awed by the scope of his interests and of his knowledge. His public addresses and his writings were characterized by the brilliant highlighting of every facet of Christian living. As scientists, we are particularly proud of his interest in the field of science. His scholarly summation of the position of science and of scientists in our day was clearly enunciated in an address before the Pontifical Academy of Sciences:

> By your research, your unveiling of the secrets of nature and your teaching of men to direct the forces of nature towards their own welfare, you preach at the same time, in the language of figures, formulae and discoveries, the unspeakable harmony of the work of an all-wise God.
>
> In fact, according to the measure of its true progress and contrary to affirmations advanced in the past, true science discovers God in ever-increasing degree—as though God were waiting behind every door opened by science. We would even say that from this progressive discovery of God which is realized in the increase of knowledge, there flow benefits not only for the scientist himself when he reflects as a philosopher—and how can he escape such reflection?—but also for those who share in these new discoveries or make them the object of their own considerations[1].

In addressing himself to the Academy Our Holy Father was speaking to an august body of world-renowned science scholars, the existence of which testifies to the sustained interest of the Church in science throughout the centuries.

The Pontifical Academy is the culmination of a long unbroken academic line which dates back to 1603, when a young Italian nobleman, Prince Frederigo Cesi, organized the "Accademia Dei Lincei." From its inception its avowed purpose was the furtherance of physical, mathematical and philosophical studies to which Prince Cesi and his colleagues, Francesco Stelluti, Anastasio De Filius, Giovanni Echio, Fabio Colonna, and Johan Heck, devoted themselves[2,3,4]. Prince Cesi saw the Academy as a way of life. Through it he hoped to encourage those interested in and desirous of expanding the field of learning by study, enquiry and discussion.

It was his firm belief that only through creation could we again reach the Creator. To him the goal of the Academy was to be achieved, not only by the acquisition of a knowledge of the world in which we live, but also by the zealous dissemination of learning. The sincerity of his interest was convincingly manifested when he turned over his own excellent library, botanical garden and museum to the use of the academicians. The prince and his colleagues, ardent intellectuals all, chose the sharp-eyed lynx as the emblem of the academy to remind them of the necessity of keenness of vision in the quest for truth[2].

Such illustrious names as those of Galileo Galilei, Johann Faber, and Father Pallavicino, S.J., appear on the roster of the early members of the Academy[2,3]. With the death of Prince Cesi in 1631 a marked decline in its activity was noted; however, the enthusiasm and prestige of thirty years was not entirely quelled. Cesi's successor, Cassiano Dal Pozzo, strove, with a moderate degree of success, to retain the original spirit. In 1745 Giovanni Bianchi, a naturalist, became interested in the Academy and revitalized it for a time. Pope Benedict XIV renamed it the "Academy of the Nuovi Lincei," but it does not appear to have been influential during this period. In 1847 Pope Pius IX brought the Academy back to a modicum of vigor, renaming it the "Pontificia Accademia dei Nuovi Lincei" and endowing it with an annual income from the vatican treasury. At this time, too, it began the publication of its *Atti* (Annals).

The Academy seemed destined to pass through a stormy period of history. With the capture of Rome and the overthrow of the temporal power of the pope in 1870 came a division in the organization. The majority of the members insisted on remaining pontifical; however, some of the academicians broke from the group to form "La Reale Accademia Nazionali dei Lincei," with financial aid from the Italian government. This off-shoot of the original academy began the Italian counterpart of our National Academy of Science[3]. It was at about this same time that the other famous academies—those of Paris, London, and St. Petersburg—of which the Pontifical Academy was a prototype, were established[4].

The great Pope Leo XIII encouraged the development of the Academy. He was ably assisted by Father Gianfranceschi, a physicist and an unusually capable or-

ganizer. During Pope Leo's pontificate a new constitution was drawn up and the publication of *Memorie*—one series a thirty-two volume work, the other comprising sixteen volumes—was undertaken. He gave high tribute to the Academy and its members in a letter to its patron, Cardinal Oreglia:

> We have considered worthy of much commendation and from the beginning of our pontificate We have fostered with special kindness the Pontificia Accademia dei Nuovi Lincei, whose obedience and loyalty even in the present difficult time have approved themselves to Us[2].

It remained for Pope Pius XI, a scholar with a keen interest in science, to take the final step in reorganizing the Academy as a pontifical, international institution, and appointing seventy academicians. On October 28, 1936, by the *Motu Proprio*, "In Multis Solaciis," he officially organized the oldest scientific academy in existence under the title of "Pontificia Academia Scientarum," the Pontifical Academy of Sciences[2, 4]. In the words of *Motu Proprio:*

> We, in the fulness of our power, of our own free will, and after mature deliberation, restore this house of studies according to new norms and declare the same, "The Pontifical Academy of Sciences"; at the same time We promulgate the Statutes hereunto appended, as proper to it, in accordance with which the assembly is to be guided in the future[2].

The *Motu Proprio*, the Statutes, and the names of the members of the Academy were published in the *Acta Apostolicae Sedis* for October the twenty-eighth of that year[2]. There, the end and scope of the Academy was given as: "The Pontifical Academy of Sciences proposes to encourage the study, development and history of the physical, mathematical, and natural sciences."[2] The Academy was pledged to examine and discuss the important questions of science and mathematics by means of dissertations and treatises; to undertake the publication of scientific works; to conduct research and to assist others in their investigations; and to hold conferences and convoke scientific congresses.

In the selection of the first seventy members from among various scientists of high honor in the countries throughout the world, the Holy Father was influenced by the importance of their research and the publications which they contributed to the advancement of the sciences, as well as by their reputations as scholars in the ranks of the learned. The membership of the Academy included ordinary members, who were clerics and laity, Catholics and non-Catholics, and who were declared academicians for life. Five honorary members were appointed and included the Cardinal Prefect of the Sacred Congregation of Seminaries and Universities, the Cardinal Secretary of State, and the Cardinal Vicar of Rome. Various officials of the Holy See, for the time in which they remain in office, were declared supernumerary members. These were: the rector of the Vatican Astrophysical Observatory, the prefect of the Vatican Archives, and the rector of the Missionary Ethnological Museum. Father Agostino Gamelli, O.F.M., professor of applied psychology at the Catholic University of the Sacred Heart in Milan, was appointed the first president of the newly reorganized Academy[2]. At that time Father Agostino was said to have possessed "the most remarkable temperament for scientific leadership the Roman Catholic Church has had for many years."[4]

Among the Pontifical Academicians honored by Pope Pius XI were six Americans: George D. Birkhoff, professor of mathematics at Harvard University; Alexis Carrel, professor of biology at the Rockefeller Institute; Robert A. Millikan, director of the Norman Bridge Laboratory of Physics at the California Institute of Technology; Thomas H. Morgan, director of the Wm. G. Kerckhoff Laboratory of the Biological Sciences at the California Institute of Technology; George Speri Sperti, director of the Institutum Divi Thomae of the Catholic Athenaeum of Cincinnati, and Hugh S. Taylor, professor of chemistry at Princeton University. Doctors Birkhoff, Millikan, and Morgan were the non-Catholic appointees in this group[4]. Of the remaining academicians named by His Holiness thirty-three were Italian, five were French, five were German and five were Belgian. Holland had four representatives, while England had three, Austria had two, and Czechoslovakia, Poland, Portugal, Denmark, China, Norway and Argentina had one representative each[4]. These representatives numbered among them such famous men as Bohr, Debye, Marconi, Picard, Planck, Rutherford, Schrödinger, Whittaker, Volterra, Abderholden and Levi-Civita[5, 6, 7].

Pope Pius XI also provided a home for the Academy, the Casino of Pius IV, in Vatican City. It is a charming Renaissance pavilion in the Vatican Gardens, originally meant for the afternoon relaxation of the Papal Court. Pope Pius XII added a new wing and had the garden surrounding it re-landscaped to provide an impressive setting. In May of 1937, upon completion of the extensive reorganization, the formal opening meeting of the Academy was held. His Holiness anticipated this meeting with eagerness but ill health made it impossible for him to attend. Speaking on his behalf, his Secretary of State, Eugenio Cardinal Pacelli, delivered the opening address. In speaking to these distinguished scientists from fourteen countries he said, ". . . the homage of the created intellect will never be more worthy of the Creator than when it is illumined by the splendors of science."[4]

It was but a short time after this opening meeting that Cardinal Pacelli became Pope Pius XII in which capacity he continued his impressive and learned lectures to the Pontifical Academy. He delivered addresses on such topics as, "Science and Religion," "The Age of the Solid Crust of the Earth," "The Age of Meteorites," "The State and Quality of Original Matter," "The System of Natural Laws," "Max Planck's Investigation of the Atom," "The Limits of Science," "Modern Science and the Existence of God," and "Science and Philosophy." Scientists throughout the world recognized the Pope as a scholar, as one of their own.

Today the roster of the Pontifical Academy remains essentially the same as that proposed by Pope Pius XI.

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The International Yard and Pound

The Directors of the following standards laboratories:

Applied Physics Division, National Research Council, Ottawa (Canada)

Dominion Physical Laboratory, Lower Hutt (New Zealand)

National Bureau of Standards, Washington (United States of America)

National Physical Laboratory, Teddington (United Kingdom)

Nationl Physical Research Laboratory, Pretoria (South Africa)

National Standards Laboratory, Sydney (Australia)

have discussed the existing differences between the values assigned to the yard and to the pound in different countries. To secure identical values for each of these units in precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definition:

> the international yard equals 0.9144 metre;
> the international pound equals 0.453 592 37 kilogramme.

It has also been agreed that, unless otherwise required, all non-metric calibrations carried out by the above laboratories for science and technology on and after July 1, 1959, will be made in terms of the international units as defined above or their multiples or submultiples.

> The preceding announcement is being made concurrently by all the laboratories listed above. The following paragraphs provide explanatory material concerning the background and use of the new units within the U. S.

The international inch, derived from the international yard, is exactly equal to 25.4 millimeters. This value for the inch has been legally adopted by Canada. Also this value was approved by the American Standards Association for "Inch-millimeter conversion for industrial use" in 1933 (ASA Standard B48.1-1933), was adopted by the National Advisory Committee for Aeronautics in 1952, and has been adopted by many standardizing organizations in other countries.

At present for the calibration of line standards and end gages having nominal lengths expressed in inches, the National Bureau of Standards is using the inch defined by the Mendenhall order (Fundamental Standards of Length and Mass, Bulletin No. 26, United States Coast and Geodetic Survey by T. C. Mendenhall) published in 1893. The values corresponding to this order are approximately

1 yard = 0.91440183 meter;
1 inch = 25.4000508 millimeters.

These are derived from the exact relation

$$1 \text{ yard} = \frac{3600}{3937} \text{ meter.}$$

The inch used by the National Physical Laboratory of the United Kingdom for its calibrations is defined by the equation

1 inch = 25.399956 mm.

It will be noted that the International Inch is approximately 2 parts per million shorter than the inch presently used by the National Bureau of Standards, and somewhat less than 2 parts per million longer than the inch now used by the National Physical Laboratory. To avoid possible confusion, during the transition period National Bureau of Standards calibrations of length or mass expressed in English units will embody a statement indicating clearly the unit which has been used if the choice introduces a significant difference in the calibration values. Furthermore, if the accuracy of the calibration is such that the certified values would be the same in either "International" units or the older units, the qualifying adjective "International" will not be used, i.e., the values will be expressed, for example, as so many inches or pounds.

The Coast and Geodetic Survey has requested the following exception with which the National Bureau of Standards concurs.

> "Any data expressed in feet, derived from and published as a result of geodetic surveys, shall tacitly bear the relationship:
>
> $$\text{One foot equals } \frac{1200}{3937} \text{ international meter.}$$
>
> This relationship shall continue in being, for the purpose given herein, until such a time as it becomes desirable and expedient to readjust the basic geodetic survey networks in the United States, after which the ratio, as implied by the international yard, shall apply."

This unit shall be referred to as the American Survey Foot. Inasmuch as there is little or no interchange of survey data, where the foot measurements are used, with industrial and scientific data, where the international units will be used, it is anticipated that no confusion will result from this dual usage. For example, base line surveys which might enter into a velocity of light determination would invariably be made in terms of meters.

The values of the pounds currently in use in the United States, United Kingdom and Canada are as follows:

1 U. S. pound	=	0.453 592 4277 kg.
1 British pound	=	0.453 592 338 kg.
1 Canadian pound	=	0.453 592 43 kg.
1 International pound	=	0.453 592 37 kg.

The relative differences in the various pounds are substantially less than in the yards but since masses can be measured with greater accuracy than lengths, the differences can be significant. The present British pound is about one part in ten million smaller than the international pound, whereas the U. S. and Canadian

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Christian Legends in Nature

• By Sister M. Henriella, F.S.P.A.
CATHEDRAL HIGH SCHOOL, SUPERIOR, WISCONSIN

Christian folklore reflects the Christian's love of God and his love of God's creatures.

Sister Henriella discusses some of the beautiful legends which Christian people have drawn from nature.

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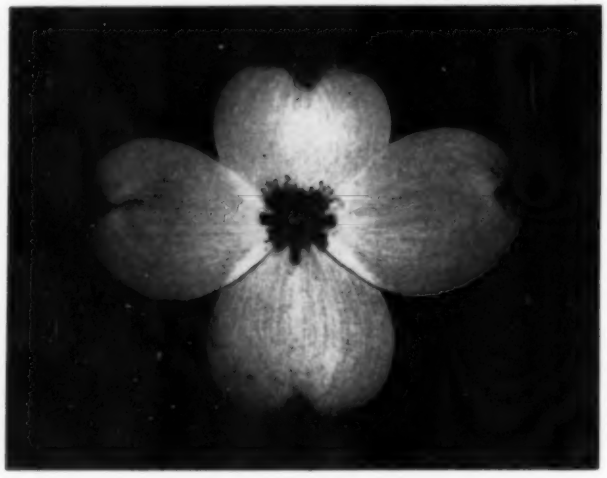
Nature's gifts to us come in many forms. It was to nature that the earliest man looked for his food, shelter, fuel and medicine. Likewise it was most natural that the early Christians would weave their religious beliefs, legends, and proverbs about the fauna and flora with which they were familiar. The Christian attached mystical and spiritual meaning to various plants and animals thereby enabling himself to recognize more readily the divine truths of the Christian religion. Many of the legends are still to be found in our Christian music, literature, and art.

There is the legend of the dogwood tree *(Cornus florida)* which is widely believed to have been the tree of which the Cross of Calvary was made. At the time of the Crucifixion of Our Lord the dogwood had been a tree the size of the oak and maple. Legend has it that because of the strength of its wood, it was selected for the timber of the cross. The choice greatly distressed the tree. As Jesus hung on the cross he sensed the anguish and in return for the pity and regret shown by the dogwood said that it would never again grow large enough to be used as a cross. Its slender twigs, moreover, would be bent, its blossoms would be in the form of a cross, and the outer edge of each bract would bear the nail prints. In the center of the flower would be a crown of thorns so that all who looked at it would remember.

Photo, V. Deer, C.S.Sp.



Dogwood Flower

The early Christian traditions, however, are not in agreement as to the source of the wood that was used for the cross. In Poland it is believed it was not the dogwood but the poplar or quaking aspen *(Populus tremuloides)*, that was selected for the wood of the cross and for that reason it has never ceased to shudder for the part it played in the great tragedy. Not a few French Canadians refuse to cut "popple" because of belief in this tradition. Perhaps these people would be consoled by the belief set forth by another legend which states that the poplar trembles, not because it figured in the Crucifixion of our Lord, but because it was filled with wrath when Judas chose it as the tree on which to hang himself. This legend, however, is contradicted almost immediately by the color of the red bud, or Judas tree, which is believed to burn with shame because Judas hanged himself upon it. This legend must be well known, at least in certain sections of the country, for when Oklahoma made the red bud or Judas tree its State Flower in 1937, a great storm of criticism was aroused by many people who considered the red bud the unluckiest tree in the world since it was associated with the suicide of Judas.

Red Bud or Judas Tree

In parts of Germany it is believed that the pear *(Pyrus communis)* was used for the wood of the cross. The legend states that after the death of Christ, the wood took root and produced blood-red flowers, blood-red fruits, and even red-veined leaves. In Pomerania it is believed that a pine *(Pinus)* was the tree involved in the Crucifixion and since then the pine has always produced its branches in cross-like whorls. Even the parasite mistletoe seems to have figured in the legends of the Cross, for it is said that the mistletoe *(Viscum album)* was once a full-grown tree that sank its roots firmly in the soil. After its timber was cut for the cross on which Christ died, the mistletoe tree was condemned to be a humble and despised parasite living on other trees until the end of time.

In an old Spanish tradition the passion flower *(Passiflora)*, a native of South America, is credited as an aid in the conversion of natives to the Christian religion. The interpretation of Aldinus of Cesera is probably the one on which many of the legends are based. The bud of the flower was looked upon as symbolic of the Eucharist. The blossom when not entirely open suggested the Star of the East that guided the Three Wise Men. The five sepals and five petals indicated the ten apostles present at the Crucifixion, Peter, who denied Our Lord, and Judas, who betrayed Him, being absent. The purple blossoms were the purple robe which was put on Christ in mockery. The white blossoms represented the purity and brightness of God.

The column in the center of the passion flower represented the vertical beam of the cross above which were found three or sometimes four small stems which stood for the nails. Surmounting the column was the corona, symbolic of the crown of thorns. Around it was a veil of fine hairs colored like peacock feathers, seventy-two in number, which were said to correspond to the number of thorns of which the crown was composed. The filaments suggested the scourge by which the Saviour was smitten. The small seed vessel was the sponge filled with vinegar, which was offered to quench His thirst. The five deep red spots upon each of the leaves were the five wounds. Hence the name given it by the Spaniards, flower of the five wounds.

The flowers grew singly on the stem, typifying the loneliness of Christ. The leaves were set on the stock singly, for there was one God, but they were triplicate in form to testify to the Trinity. The plant was a vine and required support. So the Christian, who would aspire, needed Divine assistance. The bell shape assumed by the flower when opening and fading meant that God did not choose to reveal the mysteries of His power until such time as should in His infinite wisdom seem best. Christendom seems to have accepted these ideas and they became a part of the folk-lore of the Christian World.

According to a Jewish legend, the raven was originally white, but its feathers turned black when it failed to return to the ark from which Noah had sent it to find out if the flood had abated. Because of the blackness of its plumage, its supposed habit of devouring the eyes and the brain of the dead and its liking for spoiled flesh, the raven was selected as a symbol of the Devil, who throws the soul into Darkness, invades the intelligence, and is gratified by corruption.

Legendary natural history states that young lions are born dead, but come to life three days after birth when breathed upon by the sire. Thus, the lion became associated with the Resurrection, as a symbol of Christ, the Lord of Life.

According to ancient legend, the huge body of the whale was often mistaken by mariners for an island and ships anchored to its side were dragged down to destruction by a sudden plunge of the great creature. In this way, the whale came to be used as a symbol of the devil and of his cunning, and the whale's open mouth was often depicted as representing the open gates of Hell.

In Christian symbolism, the red rose is a symbol of martyrdom, while the white rose is a symbol of purity. The interpretation has been current since the earliest

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PASSION FLOWER (Passiflora)

Automatic Analysis

• **By George L. Buc, Ph.D.,** *(Rutgers University)*
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Advertisers of household appliances boast of the fact that their products have freed the housewife from drudgery and have given her more time for recreation. Modern laboratory instruments have freed the scientist from routine and tedious tasks and have given him more time for thinking.

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If justification for interest in automatic analysis is needed, it may be found by considering pharmaceutical screening programs where as many as 40,000 materials have been employed. Any reasonable estimate of the average number of analyses required per compound screened results in an almost astronomical total of analyses. Expansion of the search for new pharmaceutical products implies an increase in the number of analyses required—a number which is already a large one.

In order to keep up with an ever increasing analytical task it is natural to turn to automation and robotization. The apparatus and instrumentation industry has to a great extent already done this and the trend will certainly continue. The present status is a good guide to the future and it will be presented in terms of commercially available apparatus.

Infrared spectrophotometry is a powerful tool in qualitative and quantitative analysis. The infrared curve of a compound reveals to the expert a considerable amount of structural information even when the compound is a complete unknown. If the infrared curve of an unknown compound matches that of a well known material the unknown has almost surely been identified. When the infrared curves of the components of a mixture are sufficiently difficult—as is often the case—infrared affords quantitative nondestructive analysis.

Modern infrared spectrophotometers draw out infrared curves in about 12 minutes. Several things are done automatically. First the wavelength is automatically scanned and secondly the measurement of transmission at each wavelength is automatic. A third automatic feature is the plotting of the resulting data in the form of an infrared curve.

The use of such infrared spectrophotometers is sufficiently commonplace in modern laboratories that the value of the automatic features can perhaps best be seen by comparison with the non-automatic apparatus from two decades ago. The older apparatus was manually operated and data were hand plotted. Consequently it required about 12 hours to produce a curve which now requires 12 minutes. Thus automation may be estimated to have improved the operation by a factor of 60. This is not the only measure of the benefit of automation. The skill required has been substantially reduced as has the ratio of working time to elapsed time.

It has recently been suggested by Albert Szent Gyorgi, the Nobel Prize winner, that the key to physiological activity of some materials lies in their fluorescence. Epinephrine, tyrosine, morphine and dihydroxyphenylalanine are known to fluoresce in the ultraviolet. Their fluorescence thus may give hints on their activity as well as serve as a sensitive analytical method for fluorescent materials in the presence of large amounts of non-fluorescent materials.

Automatic apparatus is available to plot fluorescence as a function of excitation wavelength or fluorescence as a function of wavelength when the excitation wavelength is fixed. As in infrared work the older manual methods were almost hopelessly slow and so were only infrequently employed.

Neither infrared or fluorescence apparatus presently available incorporate one automatic feature that appears desirable. They automatically obtain and plot data but they do not take up samples, put them in position for measurement, and set them aside when the measurement is finished. When a reliable automatic measuring and plotting device has added to it a reliable robot sample taker then the apparatus can operate twenty-four hours a day without attendance. The savings in time and money which can be achieved thereby hardly need enumeration.

In the counting of disintegration of radioactive materials robot sample presentation has already been provided. Apparatus is available which takes each sample in turn, presents it to the counter, makes and prints out the count and goes on to the next sample. A degree of intelligence and sophistication has been built into this chemical robot. It can either be set to count a given number of counts and print the time or count for a given time and print counts. If for some sample the desired given number of counts requires too long a time the robot can be set to automatically abandon that sample and proceed to the next.

It is not particularly expensive to build into a robot some limited useful degree of sophistication. Usually it is quite expensive to build in really extensive judgment. Fortunately simple judgment is often all that is required.

In all industry, as in the pharmaceutical industry, the analysis of materials for water is of considerable concern. The reason for the concern is in part an economic one. Producer and consumer alike recognize that some moisture almost inevitably accompanies any product. It is usually in the producer's interest not

to over dry material and in the consumers' not to accept over wet material. In the analysis of organic materials for their carbon and hydrogen content the hydrogen is usually converted to water and this gives another reason for wanting better water analyses.

Some recently available apparatus is based on a new invention which employs an old principle and a new material. The principle is electrolysis and the material is Teflon. A pair of platinum electrodes are wound inside a Teflon capillary which is coated inside with phosphorous pentoxide. At a given flow rate of a moisture containing gas through the capillary the electrolytic current which decomposes the water absorbed in the phosphorous pentoxide is a direct measure of the water content of the gas.

The analogous manual operation would be to measure a volume of gas, put it in contact with an absorber of moisture and measure the gain in weight of the absorber by weighing it before and after contact with the gas. The automatic apparatus reduces this to the reading of a meter calibrated directly in water content.

Nuclear magnetic resonance has also lent itself to automation in moisture determination. In nuclear magnetic resonance methods the sample is put in a magnetic field and a radio frequency field is applied to it. The frequencies which are absorbed depend to a first order of approximation only on the nuclear properties of the elements in the sample and to a second order on the environment provided by the kinds of and position of the atoms in the same molecule. Thus nuclear magnetic resonance is a tool for both elemental and structural analysis. The hydrogen atom in any liquid molecule gives a characteristic response and if water is the only liquid containing hydrogen the hydrogen response is a measure of the water present. Thus the measurement of water in a water insoluble starch is relatively simple while the measurement of the water content of a sugar solution is not feasible.

The method is non-destructive and it has the further advantage that the sample can be enclosed for measurement in a glass ampoule in which it can neither gain nor lose moisture during measurement. Usually the weight of sample must be fixed to make the apparatus direct reading. The measurement time is about two minutes.

Counting is not always considered an analytical method but it actually is often so employed. In clinical chemistry blood cell counts afford an example. In industry the number of particles per unit weight of a powder is often of interest as an indirect measure of particle size. The determination of particle size distribution also involves counting.

Manual counting procedures are at best tedious and slow. Because counting is slow relatively few counts are made in any one determination so that statistical error is large. Judgment is usually involved in manual counting. Thus in counting particles in a given area some decision must be made about what to do with particles on the boundary of the area. Although it is not impossible to build decision making units into a robot it is better to avoid doing so if possible.

A recently designed apparatus for counting blood cells and other particles uses a method of avoiding judgment in the robot that has become quite common in counting techniques. The method may be called the turnstile method. The particles are diluted so that only one at a time is ever in the counting mechanism and are made to go by it in single file. In this case the turnstile is a small orifice which separates two electrodes which are bathed in a conducting solution. As each particle goes through the orifice the electrical resistance between the electrodes changes and the change is converted to a voltage kick which trips an electronic counter.

Fifty thousand particles in about a half cm^3 are counted in less than half a minute. The size of the kicks bears such a relationship to the size of the particle that particle size distributions can be done with the aid of a kick sorter. This particular apparatus does not feed itself its own samples but it could readily be made to do so.

In screening compounds for desirable activity large numbers of animals are used and large numbers of tissues must be prepared for examination. Part of the preparation consists of a programmed advancing of the tissue through graded series of drying agents and finally impregnating the tissue with Tissuemat prior to slicing. Once the proper solvents are known and the program is worked out the actual operation requires little skill. It does require considerable reproducibility and reliability.

The requisite reliability and reproducibility have been incorporated into an automation in which the tissues are properly supported and dipped, with stirring, into each of the solvents for the required time. The program is set on the circumference of a timing disc with set screws and is readily changed. It is quite commonplace for tissues to be started in the late afternoon and be ready in the morning.

Physical methods of analysis lend themselves to automation and often to non-destructive methods of analysis perhaps better than classical chemical methods. It is none the less possible and desirable to automate chemical analysis. This has been done in an apparatus which takes its own samples, does a chemical analysis with a colorimetric finish and records the results.

The apparatus has heating, mixing and dialysis sections which can be placed in any required order in any required number. The samples to be analyzed are placed on a turntable where each is picked up in its turn by a pumping system. Once it is picked up the sample stays in a closed tubing system. Reagents are brought into the system by pumping these from reservoirs through tubing which joins the sample tubing at appropriate points. Thus almost any succession of reagent additions can be duplicated

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The Health of Plants, Animals, and Man

A Review of Currently Applied Nutrition

• By **J. F. Wischhusen**
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Folklore and prejudice die slowly. Nutritional science has made great progress, yet many popular misconceptions concerning diet persist.

This article is from a paper presented at the Twenty-fifth Annual Conference of Randleigh Farm, Lockport, New York, September 20, 1958.

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How many men at one time and without knowledge of science and technical skill would it take to build an airplane? The answer to this would be close to infinity. Airplanes are built to exact specifications, and perform as designed.

Equally unanswerable is the question how the average adult could specify the nutrients required by plants, animals, and man for their optimum health. What our technical sciences have accomplished in building jet planes and atomic submarines, our biological sciences may also be expected to accomplish with blueprint specifications for producing healthy plants, animals, and man in the way of nutrients essential for that purpose. They are presently behind in this goal by about 75 years.

The incentive for the phenomenal advance in our technical sciences, no doubt, was in a large measure provided by considerations for national security. To obtain a superiority in stamina, and intelligence may conceivably prompt a nation to advance its population in the skill to improve its health through nutrition. Specifications are necessary toward this higher nationality status. The value of this would lie in abolishing sickness, and much poverty, delinquency, and mental troubles. A nation leading in this direction would most likely have its methods emulated by many others without the need for financial aid or diplomatic persuasion. But any individual, family, or group of people interested in true economics that concern their own persons, need not await any such national directive, and can at any time proceed to improve their plane of nutrition by learning to select foods according to nutritional specifications for optimal body health.

Soils and Plants

Soil analyses when properly used, furnish an inventory of plant food available in a particular soil. Plant tissue analyses furnish a record of plant food supplied to the growing plant. Both furnish valuable information for feeding plants. Their interpretation into farm practice depends on knowledge of how crops grow, and how best to furnish their requirements. The way this is applied at Seabrook Farms in New Jersey is described by Frank App[1].

The use of fritted trace elements in slowly but steadily available form, not subject to leaching, nor with dangers of root injury or toxic effects, can now also be specified for whatever soils and crops may be in need of them[2]. So can certain organic substances called chelating agents, that assure the uptake by plants of a particular essential element without the interference of another[3] and thus provide specific nutrients. Increased crop yields have been reported from the use of exceedingly small amounts of beta amylase triiodide as a stimulant to soil micro-organisms[4]. Starches and sugars applied to the soil as reducing agents may become practical and profitable. Then there are now also the Gibberellic acids which normally occur in plants, but a supply of which stimulates plant growth further, and does for plants what nutritional supplements do for livestock[5].

Agriculture may indeed be the first biochemical industry to practice what may be called "prescription crop production" for specific objectives, that include food of known nutrient composition. Individuals would thus be enabled to choose foods for optimum health, and create a demand for them. Anyone still having a preference for foods on the basis of taste, eye appeal, or convenience to serve, but of substandard nutritional value, would be doing so on his own responsibility.

Many people today absolve themselves of this responsibility, and blame the soil, the fertilizer, and the food processors for our nutritional shortcomings. It will most likely be found that on the road to good health, abstinence from the highly processed foods of civilization is a cardinal requirement.

"Organically Grown Foods"?

Militant but obviously misguided groups cling, to the belief that crops should be "organically grown" to be nutritious. This designation is clearly a misnomer because *all growth is organic synthesis from inorganic elements.* Soil conditions and the weather determine crop yield and crop quality. No plant assimilates organic matter. Soil particles, air, water, carbon dioxide are all inorganic compounds and they constitute the principal and decisive crop producing factors. Desert soils need mainly water to produce abundant and nutritious crops. Nutriculture, such as hydroponics, and sand-culture methods prove that plants can grow entirely in an inorganic medium, without organic matter other than what is contained in the seeds. There is no organic medium in which to grow plants. Organic matter is needed for sandy and loam soils to promote the life of soil micro-organisms that make inorganic matter available for plants to assimilate as ions. The composting of manure, organic wastes, crop residues, leaves, etc. make the formation of soil colloids possible

and thus improve soil structure. Consequently organic materials when used as a fertilizer will improve certain soils, but none of this means that anything "grows organically." A better designation might clarify what these votaries of "organic gardening," etc. really mean. The ideal amount of organic matter for any soil may be specified, and can best be supplied by inorganic fertilizers via green manure. Our high organic soils, the Florida Everglades, our peat and muck soils produce poor crops of low nutritional values without the aid of ingorganic fertilizers of suitable chemical composition and physical condition.

What Is "Organic"?

This question may well be raised at this point. The living organism differs from any known association of the elements outside of it. This is due to the ability of the living organism to utilize radiant energy. And food is stored energy-sunshine. Life and mind may be considered as levels of varying complexities in the arrangement of matter composed of atoms. Organic chemistry is merely a more complicated inorganic chemistry. The difference between the compounds formed in the living organism and outside of it is a difference not of kind, but of complexity. The basic unit of the living organism is the cell. Its plan of organization does not differ intrinsically from that exhibited by inorganic materials, except that it has become amazingly complex. The atoms of carbon, hydrogen, nitrogen, oxygen, sulfur, etc., that form protoplasm are the same in the living organism as in soil, air, water. There is a continuous interchange of these atoms from the inorganic to the organic form of matter and back again to the inorganic. The structural features, and the fundamental behavior of any atom does not change when it becomes a part of the protoplasm or of a living organism.

"Natural Food"

Natural food is another misnomer preference for a food supply, and is as confusing as the expression "organically grown foods" because all growth is natural. Both concepts arose apparently in protest to the devitalized carbohydrates and fats now constituting 60% of the average American diet. At best they promote the use of foods of unknown quality but such foods have little effect upon malnutrition nor influence disease conditions that exist. Poor soils or poorly fertilized soils produce "naturally" either small crops or crops of substandard qualities.

Plants in optimal health provide feed and food of optimal nutritional value for livestock and man. They do not however transmit from the soil the number and amounts of essential nutrients required by the higher forms of life. Each form of life is concerned only with its own growth and propagation. The lower forms are not mindful that they serve the purpose of supplying the requirements of the higher forms that may use them as food. Foods from all sources require examination of their nutritional properties. These vary constantly. Hence the balancing of meals has developed into a culinary art, and it was natural that the art of eating preceded the science thereof. Such science is made possible only through food chemistry, and "natural food" sources are not scientifically correct food sources. If perchance the expression "Natural Foods" is to designate that no commercial fertilizers were used in growing them, one need only think of the poverty of soils, and their consequent poor crops, of vast areas on this Hemisphere, in Africa, the Near East, India, and certain parts of the Far East where malnutrition is the lot of large numbers of people who depend on "Natural Foods." Improved agricultural practice and the use of plenty of inorganic fertilizers in correct and harmonious proportions are the answer to their problem of more and better food. The injudicious use of any fertilizer, organic or inorganic, can be responsible for crops of poor quality, or crop failures altogether. Any line of differentiation should therefore not be made between "naturally grown foods" vs. "foods grown with commercial fertilizers," but in the first place between "raw foods" vs. "processed and refined foods," and secondly between "foods grown on fertile soils" vs. "foods grown on poor or unproductive soils." All soil deficiencies and excesses show up as crops of unbalanced and poor food values. But any soil can be made fertile through suitable soil amendments.

Insect Pests

Major outbreaks of grasshopper pests in Colorado, Kansas, and three other southwestern states have pointed up the immense importance of keeping parasites under control that compete with man and livestock for a food supply. It shows the futility to depend on natural checks and balances for insect control[6]. The control of disease germs on the other hand, is shown more and more to be a problem of nourishing their hosts, both plant and animal, to repel them, or to subdue them with beneficial micro-organism. Undernourished plants and animals attract pathogens, healthy bodies repel them. Total destruction by the one of the other appears unlikely. But many great clinics and sanitariums throughout the world are successfully using raw foods for both preventive and remedial purposes in a wide variety of disease conditions. These raw foods may be selected according to nutrient quality specifications[7], show the value of primitive foods.

Livestock

What soil analyses and tissue tests are doing for the identification of plants of high nutritional value, blood-, milk- and even urine-analyses can do for domestic animals. Nutritional deficiencies and excesses may thus be determined and translated to the food supply, as well as to the health of the animal and its productivity. This requires the constant attention of the feeder at feeding time. Not only must the composition of the commercial feeds be known, but also the composition of the local forage, the grains, silage and the water supply. Feeding for animal health may be called "prescription feeding, by the feeder, at feeding time."

Specific instances in recent times concern bloat in dairy cattle, and the calcium metabolism of dairy cows. Experiments at the South Carolina Experiment Sta-

tion[8] show that bloat is associated with a phosphorus deficiency of a relative value to the nitrogen-phosphorus and the calcium-phosphorus ratios. The existence of a large excess of nitrogen in plants, or a deficiency in phosphorus for the synthesis of the essential nucleoproteins, phosphoproteins, and lecithoproteins may result in levo-rotatory glucesides, and unstable azo, azoxy and diazo organic groupings in the grazing crop, which in turn may produce bloat in farm animals. A critical deficiency in ruminants should be corrected by feeding a suitable phosphorus supplement prior to cattle being sent into pasture, to avoid both acute bloat and grass tetany from the use of succulent grazing crops. These subjects are more particularly dealt with in a lecture "Cause and Control of Phosphorus Deficient Pasture Bloat, and Calcium Deficient Grass Tetany in Ruminants," by H. P. Cooper of the South Carolina Experiment Station, Clemson, S. C.

To maintain an adequate serum calcium level in dairy cows requires not a diet high in calcium, but one high in phosphorus and low in calcium as described in "Nutrition Reviews"[9]. This explains why the feeding of a diet with a low Ca:P ration prior to calving prevents milk fever (hypocalcemia) during lactation. It also demonstrates that phosphorus is the key to the availability of calcium, and confirms the practical results obtained when dairy rations are not supplemented with calcium carbonate, but solely with 20 lbs. mono calcium phosphate per ton of feed as a calcium-phosphorus supplement. High calcium supplements to total rations result in calcium deposits tantamount to a phosphorus deficiency, and inhibit the functions of trace elements. It is obviously necessary to have not only a suitable balance between calcium and phosphorus, but also with and between magnesium, potassium and nitrogen to mention only the principal major essential elements. This involves their resorption from the animal body, especially the skeleton, as well as the solubility, mobility and metabolic efficiency of these elements from the feeds ingested. It is well known that the parathyroid glands control the calcium phosphorus level of the body. A high level of serum calcium tends to lower the activity of the parathyroid glands, and a low level of serum calcium results in their increased activity to produce the thyroid hormone that influences the mobility of bone calcium. Thus an excess of parathyroid hormone may cause removal of sufficient calcium from bone tissues to produce hypercalcemia, whereas hypocalcemia which is observed in milk-fever may result from a deficiency of the parathyroid hormone.

Salt is also frequently used to excess and this is aggravated by other sodium compounds added to feeds in so called "mineral supplements." It has further become apparent in recent years that nitrates, both as protein-nitrogen as well as nitrate- and ammonium-nitrogen are causing trouble by being excessively present in feedstuffs, and in such supplements as urea and other nitrogen compounds. A report from Maine relates that topdressing haylands after their first cutting with a heavy application of ammonium nitrate resulted in severe mastitis of all dairy cows pastured thereon.

Many dairy herds in New York, Vermont, Pennsylvania, Illinois, and Minnesota are kept in good health, in top production, free from brucellosis, mastitis, hoof-rot, breeding troubles, retained placentas and caked udders by the use of rations to which neither salt nor lime is added, but where the feed is typically supplemented with 20 lbs. mono calcium phosphate, 10 lbs. magnesium oxide, and 10 lbs. multiple trace elements especially designed to supply about seven essential elements, all per ton of feed[10]. Salt is then offered separately free choice, and iodine administered as needed. A prominent California dairy offers certified raw milk from a herd that of course is free from tuberculosis, brucellosis and mastitis, and publishes the feed ingredients used to keep their cows in such a high state of health[11]. Their method may be followed by dairymen everywhere, and this requires the use of all essential inorganic elements that are commonly classed as "minerals."

The "Non-Fat-Solids"

The non-fat solids in milk are coming in for more consideration because the milk consuming public is fast realizing that the real value of a bottle of milk is below the "cream line"[12]. Testing kits for determining total solids in milk are now displayed by the Dairy Research Branch of the USDA at Beltsville, Md., that were originally developed by commercial concerns. One of them by George A. Kastner, Sr., Batavia, N. Y.[13] who became interested in this matter in the thirties and prepared charts showing total solids, also lactose, calcium, phosphorus, chlorides and ash in milk. High acidity, gas, leucocytes, mastitis are easily discovered in the early stages with Kastner's copyrighted method, and they indicate faulty metabolism due to unbalanced mineral feeding. Milk solids having a pH of 6.9 as compared with a normal of 6.5 show by such tests large numbers of white blood cells that indicate mastitis and other udder infections. Such milk may show odors and when mixed with clean milk may contaminate the entire supply. In such cases Kastner adjusts the mineral rations with suitable supplements, mainly phosphates, magnesium and trace elements in the sulfate form.

The importance of potassium in total rations should be borne in mind. Optimum body functions depend on optimum potassium concentration in the feed, and balance with other cations, principally sodium, but also magnesium and calcium[14]. Since feeds are generally supplemented with salt and other sodium compounds, but potassium is expected to be adequately present in natural feed sources, it is apparent that the sodium: potassium ratio must be watched, and care taken not to feed salt out of proportion to the potassium naturally present, as well as the magnesium and calcium.

Human Nutrition

Man is a parasite, and like other forms of life must look to the care of his hosts, viz: the quality of his food. The average American male reaching the age of 70 is said to have consumed during his lifetime the following:

150 heads of cattle	225 lambs
310 hogs	26 sheep
2400 chickens	26 acres of grain

and 50 acres of fruits, vegetables, and potatoes.

A typical analysis of the human body shows that he retained of this vast array of foodstuffs about 200 lbs., composed of the following:

Oxygen	66.00%
Carbon	17.60%
Hydrogen	10.20%
Nitrogen	2.40%
Total Combustibles	96.10%

Thus the ash of the human amounts to about 4% and consists principally of the following:

Calcium	1.60%	Other elements are determined only as traces. The total number of elements associated with the fabric of life has been found to be 37, of which at least 25 are now considered as invariably essential to all forms of life.
Phosphorus	.90	
Potassium	.40	
Sodium	.30	
Chlorine	.30	
Sulfur	.20	
Magnesium	.05	
Iron	.004	
	3.75%	

Thus the needs of man during his life time involved the destruction, metabolism, and elimination of vast amounts of foodstuffs of which he retained only a fraction. His actual needs may be calculated from the amount of food actually eaten of approximately one kilo per day, and this would amount to 56,210 lbs. in 70 years.

The registered number of persons in the USA who suffer from chronic diseases has been computed at over 88 million, plus 4 million alcoholics, and 32 million obesities[15]. Thus half the population of this country failed to obtain proper benefits from the above food sources. But since the other half is apparently satisfactorily nourished, the question arises why not all of us benefit alike from what clearly amounts to an abundant food supply. Nutritional sciences should find this a fertile field for exploration, and be in a position to make outstanding contributions to the control of chronic disorders. That this may be expected to be on the way is pointed out by the Surgeon General, Public Health Service, USA[16].

When disorders are the result of a disturbed "mineral" balance, the first problem is to remove any excesses. Calcium and cholesterol deposits can be reduced with hydrochloric acid and lecithin. The intake of sodium determines the need for potassium[14]. Analogous with livestock feeding practices, salt and other sodium compounds are also freely added to the human diet, but potassium, as well as magnesium and the sulfates are expected to be present in whatever food is consumed without much thought of supplementation. Penicillin and other antibiotics are freely administered by doctors to infants when their convulsions, spasms, and irritabilities may concern deficiencies of such essential elements as iodine, magnesium or potassium. The function of manganese in bone formation, long known to be a factor in such animal deformities as perosis in chickens, lameness in pigs, crooked legs in rabbits, etc., in recent years has found recognition and application in the regeneration of spinal discs alongside of massive doses of vitamins D and C. Since it appears that phosphorus is the key to the availability of calcium, especially serum calcium, and that on the level of both in the body is controlled by the hormone of the parathyroid that in turn depends on iodine, it may be expected that such is also the case with humans. These three essential elements are therefore of particular importance to the diet of women during pregnancy and to nursing mothers. The recommendations of many nutritionists for the supplementation of such diets with calcium compounds other than calcium phosphates would seem to be a fallacy as this may lead to congenital deformities, cleft palates, hare lips, misshapen limbs, etc., or to calcium deposits causing bursitis, cysts, fissured bone and joint sockets. The advantages of using a calcium supplement that is high in phosphate, such as calcium glycerophosphate is thus explained, and now also clinically confirmed[17].

The health of the teeth and their supporting structures from the beginning of fetal life to adulthood, is continuously dependent on specific nutritional elements in the diet. This is comprehensively dealt with by John A. Myers, M.D., in an article[18] that recently appeared in the New York Annals of Dentistry. The role of iodine in conjunction with other trace elements is mentioned by Dr. Myers, confirming the far-reaching biological reactions in general body health for which this element is responsible.

Research on the factors that govern human health may of course be based on something more central than the nutrient composition of food sources. Man is omnivorous and therefore not dependent on what the soil produces as are the herbivora. The sources of his nutrients are immaterial, and some of the indirect criteriae of what dietary factors are essential may be ascertainable from the requirements of the beneficial intestinal microflora along the principle: "feed your microflora, it will feed you"! The quintessence of health factors may also be found in the liver, the largest gland in the human body which does the balancing of the functionings of all other glands. "Take care of your liver, and your liver will take care of you!" is a slogan recently advanced by a popular writer of medical subjects[19]. Then a way to keep free of certain pathogens deals with the alkalinity of media for growing many dangerous micro-organisms[20] such as:

Micro Organisms	*pH reactions*
staphylococcous	7.4
streptococcous	7.4 to 7.6
pneumonococcous	7.6 to 7.8
H. influenza	7.8
meningococcous	7.4 to 7.6
gonococcous	7.0 to 7.4
corymbacterium diptheriae	7.2
B. abortus	7.2 to 7.4
B. tularemia	6.8 to 7.3
Clostridium tetani	7.0 to 7.6

This shows that to avoid infections from the above disease germs the human and animal bodies must maintain a condition on the acid side of the pH scale

(Continued on Page 31)

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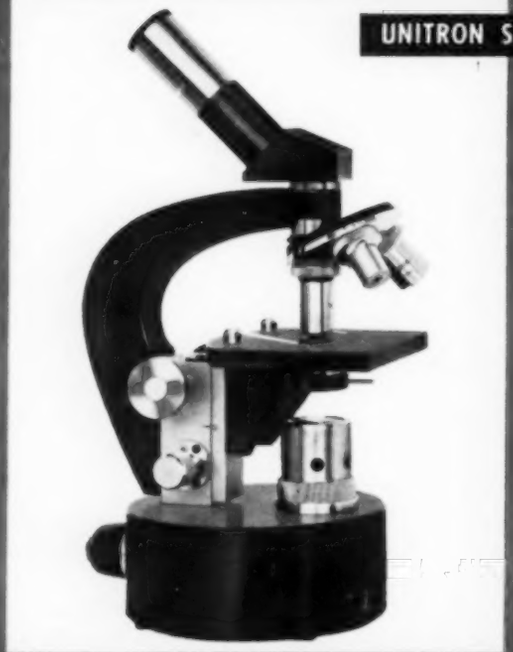

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Young Scientists' Development

• By Shirley Moore
SCIENCE SERVICE STAFF WRITER

Influence of Teacher

WASHINGTON—Teachers, individually described in such terms as "a science enthusiast who opened up whole worlds of excitement," have had the most significant influence on the development of nearly half of the 40 highly promising young scientists who are the winners in the 18th annual Science Talent Search for the Westinghouse Science Scholarships and Awards.

A study by Science Service, which conducts the Search through its Science Clubs of America, shows that the teachers named include some who taught these students in elementary school, in junior or senior high school, and professors at nearby colleges.

Information received from the parents of these 40 winners indicates the importance of teachers in the encouragement of their children's scientific talent. In some instances it was a teacher who introduced an eight- or ten-year-old youngster to an absorbing interest in birds or butterflies or stars. However, the period during which the influence of dedicated and enthusiastic teachers is most evident begins with eighth grade and continues at a high level throughout all the pre-college years.

Parents describe the effectiveness of these teachers in such phrases as "encouragement by personal interest, confidence and example," "encouraged him to enter the science fair," and "many teachers at the high school presented their subjects as exciting and challenging and gave encouragement to effort."

One-fourth of the winners report that they have received their important help and stimulation at home. They evaluate the influence of their family lives and pay tribute to their parents in such revealing statements as:

"They established a home atmosphere in which learning was respected, and instilled in me a deep curiosity which soon led me to science."

"My father taught me to appreciate the beauty and secrets of nature, showed me the importance of reading, started me on my insect and rock collections and stimulated my interest in mathematics."

"My father furnished an example of keen interest in science, gave me scientific books and magazines, discussed interesting scientific developments."

The goals of one-fifth of these young people have been stimulated and focused by scientists. The students' statements about the people who have taken time from their busy professional lives to help and encourage a younger generation of researchers are articulate and specific enough to serve as a miniature handbook on "How to Help a Young Scientist."

"She gave me an opportunity to prove myself capable to do scientific work. I was encouraged to think for myself and work without constant supervision. I saw the science that was behind classroom study and became convinced it was what I wanted to do."

"He taught me the need for complete integrity . . . that the road to scientific achievement was mainly hard work with many failures along the way, each of which must be taken as a challenge rather than a defeat . . . I learned from him the thrill that comes from a successful result after long and arduous effort."

There must be few of the world's honors as rewarding and humbling as the knowledge that one somehow has inspired a young person to feel like that. However, many scientists are earning such rewards, for they are similarly appreciated by 17% of the Honors Group of 427 high school seniors from which the 40 winners were chosen.

Another 17% of the large Honors Group name their parents, many of whom are science-trained, as the people who have most stimulated their interest and effort. Others mention college students and close relatives as their most important sources of inspiration and advice.

Only 22 of the Honors Group, three of them winners, feel either that they have supplied their own motivation or at least that no one person has had the greatest effect on their development.

On the other hand, well over half, 57% of the 427, pay tribute to their teachers as their principal inspiration.

* * *

Nobelist's Career Began In a New York Science Club

WASHINGTON—A chance for independent exploration in a laboratory for teen-aged students is a significant part of the background of Dr. Joshua Lederberg, co-winner of the 1958 Nobel Prize in medicine and physiology.

Seventeen years ago, as an active member of the Stuyvesant High School Science Club in New York City, 16-year-old Joshua won a place in the Students Science Laboratory, a research center for 30 gifted children. This was operated by the American Institute of the City of New York which about a year later turned over to Science Service the national youth program which became Science Clubs of America.

Dr. Lederberg feels that he owes a great debt to this unusual opportunity. He said in a Science Service telephone interview that such encouragement and opportunity for young students is "extremely valuable and important in their future development."

The Nobelist's own interest in science dates from his earliest childhood recollections. There had been no other scientists in his family, but his parents placed

great value on scholarship in general. His teachers encouraged him all the way through school and college, and Stuyvesant High School's excellent academic curriculum, with emphasis on manual techniques, proved extremely helpful to him in his later experimental work.

Henry Platt, then director of the laboratory and now Ph.D. psychologist of the Devereux Foundation, Devon, Pa., remembers that young "Josh" was mature in his thinking and that "his scientific curiosity was endless."

"His enthusiasm and actual capacity for independent research in the biological sciences had outgrown the facilities of the public high school," Dr. Platt told Science Service. "His appointment to the Students Science Laboratory enabled him to do independent research in cellular physiology and he had the freedom and privileges of an adult research investigator. No doubt his early training in science and opportunity to carry on research paved the way for his later achievement in science."

The laboratory that played such an important part in Dr. Lederberg's early scientific career was situated on two floors of the International Business Machines Corporation building at 310 Fifth Avenue, New York City, in space provided by the company as its contribution to the program. The laboratory was open every day until 9 p. m., and on Saturdays and holidays. It is described by Dr. Platt as having been complete with reference library, photography dark room, and workshop for design and construction of special equipment required for research investigation.

The 30 young students were chosen for their outstanding scientific talent and for their demonstrated skill in independent research. Each of the students worked as the protege of a highly competent scientist in his field of interest, who served as consultant and adviser.

The students conducted their own research seminars where they reported to each other on the progress of their work and discussed ideas and techniques. A snapshot from Dr. Platt's files shows young Joshua Lederberg lecturing on cells to a group of the other laboratory students. Dr. Platt recalls that the young scientist's research in cytology was "outstanding and very thorough."

The Nobel Prize was awarded Dr. Lederberg for his discoveries concerning genetic recombination and the organization of the genetic material of bacteria. Co-winners with Dr. Lederberg were Drs. E. L. Tatum of the Rockefeller Institute, New York, and George Wells Beadle of the California Institute of Technology.

Dr. Lederberg, chairman of the medical genetics department at the University of Wisconsin, will resign from that post in February to become professor and executive head of the new department of genetics at the Medical School of Stanford University. He received his B.A. from Columbia College in 1944, attended the College of Physicians and Surgeons at Columbia University from 1944 to 1946, and received his Ph.D. from Yale University in 1948. He organized the department of genetics at the University of Wisconsin in 1957. ●

The International Yard

(Continued from Page 9)

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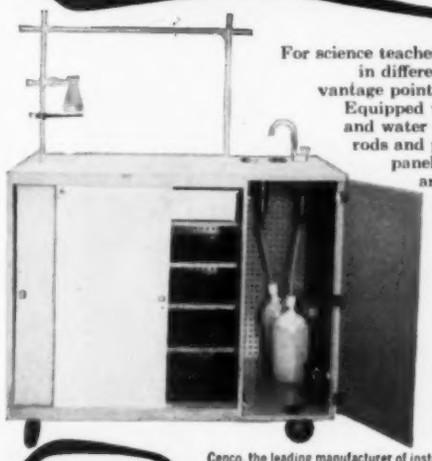

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Symposium On Evolution

To mark the centenary of Charles Darwin's *The Origin of Species*, Duquesne University will sponsor an international symposium on evolution. This symposium, which is made possible through the assistance of the Pittsburgh Bicentennial Committee, will be held at Duquesne University, on Saturday, April 4, 1959, at 10:00 A. M.

Father Cyril Vollert, Dean of the School of Divinity of St. Mary's College, Kansas, will speak on *Evolution and Religion;* Gottfried O. Lang of the Catholic University, *Human Organic Evolution—Fact or Fancy;* Frederick C. Bawden of the Rothamsted Experimental Station, *Viruses* and *Evolution;* Andrew G. van Melsen of the Universities of Nijmegen and Groningen, the *Philosophical Aspects of Evolution;* Bernard J. Boelen of Duquesne University, *Darwin Recalled.*

FATHER CYRIL VOLLERT, S.J., of the United States, obtained his Doctorate at the Gregorian University of Rome. He is Dean of the School of Divinity of St. Mary's College, Kansas. Father Vollert has published many studies concerning theological questions, including the relationship of evolution to theology.

GOTTFRIED O. LANG was born in Oberammergau, Bavaria. He studied at Brown University, the University of Chicago and Cornell University. Since 1958 he has been Associate Professor of Anthropology at the Catholic University of America in Washington, D. C. He has written ten studies in the area of his specialties and is associate editor of the Anthropological Quarterly.

FREDERICK C. BAWDEN, of England was educated at Cambridge University. Since 1936 he has been attached to the famous Rothamsted Experimental Station for botanical research. In 1958 he was appointed its director. He is the author of two books and more than one hundred articles about viruses.

ANDREW G. VAN MELSEN, of the Netherlands, studied at the University of Utrecht. He is Professor of the Philosophy of Nature and of Science at the Universities of Nijmegen and Groningen. He has published several books and many articles about science and philosophy.

BERNARD J. BOELEN was born in the Netherlands. After studying at the Higher Institute of Philosophy in Louvain, he taught for some time in Holland. Since 1955 he has been at Duquesne University as Professor of Philosophy. He is the author of one book and a number of articles about philosophical questions.

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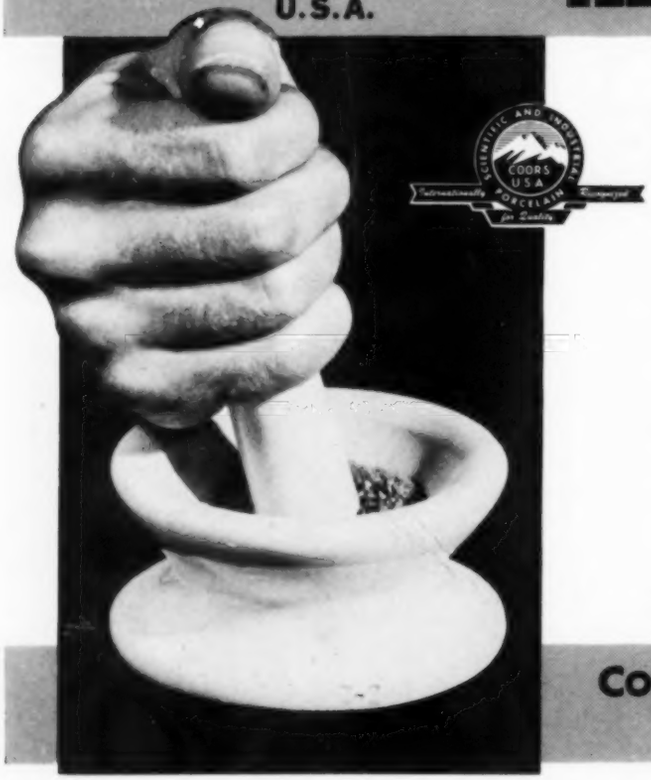

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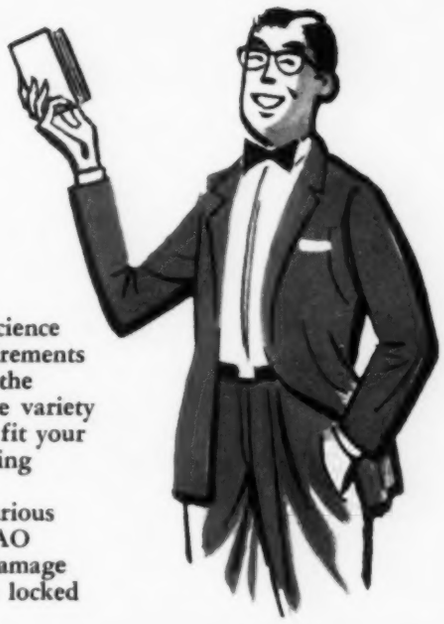

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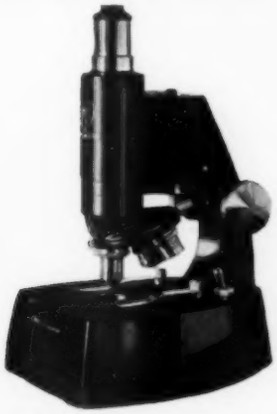

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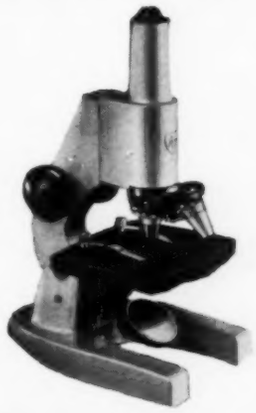
78 A low-cost teaching microscope that requires little or no instruction into the technique of microscopy. Your time is spent solely on subject matter. Built-in base illuminator assures proper illumination. Helps students observe specimens properly.



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Why Not Semimicro?

(Continued from Page 2)

students pampered in this way are not properly trained to cope with the normal shelf supplies encountered in college and commercial laboratories.

A typical SM experiment for high school chemistry is given below:

Preparation and Properties of O_2

"What weight of O_2 will be formed by the complete decomposition of 10 g of $KClO_3$? What percent of $KClO_3$ is O_2? What percent of HgO is O_2? Which is the better source on this basis?

I. *Laboratory Procedure:* Mix about 1 g $KClO_3$ with half as much MnO_2 on a piece of paper. Transfer the mixture to a 4-in. test tube with OO one-hole stopper and type A delivery tube leading to a trough of water in which five collecting vials are submerged.

Holding the burner, carefully heat the test tube, keeping the burner in constant motion. Let the first few bubbles of gas escape to rid the generator and tubes of air. Now, place the thumb over the mouth of one of the vials filled with water and bring it directly over the end of the delivery tube, still under water. The bubbles of O_2 will enter the vial and displace the water. Control the heat so that a steady flow of O_2 results. If the gas is being generated too quickly, remove the heat; however, if the water begins to suck back up the delivery tube, either withdraw the delivery tube or apply more heat. As soon as all the water is dispelled from a vial, as shown by the bubbles of gas in the trough, quickly stopper it under water and replace it with another vial of water.

II. *Properties:* Calculate the density of the O_2. Note the color, odor and taste. Invert a vial of O_2 in a beaker of H_2O. Insert a glowing splint into a vial of gas and observe the results. Heat some powdered charcoal on a spatula until it glows and quickly insert this into a vial of O_2. Repeat the above using powdered sulfur instead of charcoal.

III. *Reaction:* Test the material in the generator by dissolving a bit of it in H_2O. Filter or centrifuge the resulting suspension and to the clear liquid add a drop of $AgNO_3$. The formation of a curdy, white precipitate is a positive test for the Cl^- ion."

Directions are explicit for this minimal amount of work, but the students should be encouraged to progress beyond these basic instructions if they are able. As Schlesinger has said:[2]

"The important point is that the student be allowed, in fact required, to put his suggestions into practice if it is at all feasible; and there is no reason why he should not try out a reaction that could not possibly yield the desired result, provided he can thereby discover for himself the reason for his failure."

Semimicro is thus a valuable, safe ally for the teacher in training high school chemistry students to be America's chemists of the future. ●

[2] H. I. Schlesinger, "The Contribution of the Laboratory to General Education," *Journal of Chemical Education*, (1935) 12:52.

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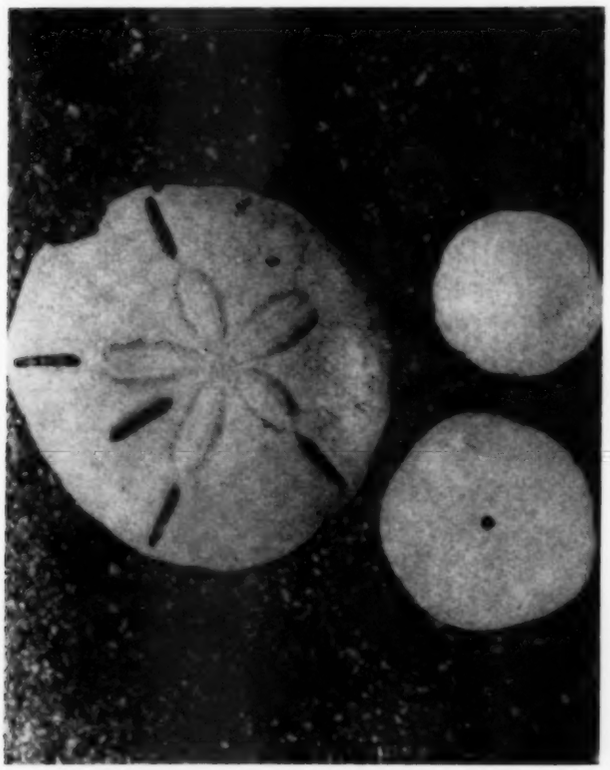
Christian Legends in Nature

(Continued from Page 11)

years of Christianity. St. Ambrose relates how the rose came to have thorns. Before it became one of the flowers of the earth, the rose grew in Paradise without thorns. Only after the fall of man did the rose take on its thorns to remind man of the sins he had committed and his fall from grace; whereas, its fragrance and beauty continued to remind him of the splendor of Paradise. It is probably in reference to this legend that the Virgin Mary is called a "rose without thorns" because of the tradition that she was exempt from the consequences of original sin.



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One cannot help but marvel at the genuine simplicity and sincerity of these legends for they set forth belief in profound truths of Christianity as well as a great admiration and love of Nature. ●

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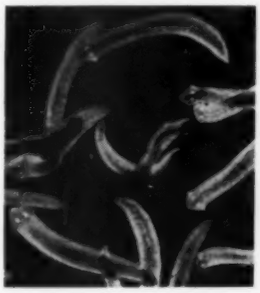

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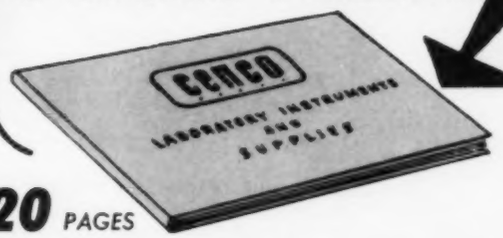

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Pontificia Academi Scientarum

(Continued from Page 8)

Vacancies in the Academy ranks are filled after careful scrutiny of all eligible candidates. The academicians vote from the list of selected names for the scientists who will be honored by membership. The elected candidates' names are then forwarded to the Holy Father for his approval. While the Academy is not restricted to Catholics, it is not conceivable that the Pope would approve the election of any scientist known to be hostile to God. Its present membership includes many Protestants and not a few Jews. It has been said to be truly Catholic in every sense of the word.

With membership, certain privileges are accorded the academicians. They are seated in special places when the Holy Father presides in solemn functions; they have free access to papal museums and art galleries; and they are entitled to wear the medal of the Academy, on which are imprinted the papal tiara and keys with the words, *Deus Scientarum Dominus*, and the name of the academician wreathed in olive and laurel. Scientists consider their election to the Pontifical Academy of Sciences a great honor. Academician Hugh Scott Taylor writes, "It is the quality of their scientific attainments in their own special fields which has brought them this distinction and I know from personal experience that they are proud that His Holiness has seen fit to honor them in this manner."[8]

On November 30, 1941, Pope Pius XII announced the awarding of the Pius XI prize for astronomy to Professor Harlow Shapley, director of the Harvard Observatory[6].

In May of 1948 Pope Pius XII named six more scientists to membership in the Academy. Two Americans were included: Professor E. A. Doisy, professor of biochemistry at Saint Louis University, School of Medicine, and Professor H. S. Langfeld, Stuart professor of psychology at Princeton University[9]. Again, in 1955, he honored fourteen world-famous scientists with seats in the Academy, raising the membership to sixty-five. No native born American was listed among the new members, but one of the academicians named was Theodore de Karman, Hungarian-born physicist, director of the Guggenheim Aeronautical Laboratory of the California Institute of Technology. Another nominee was Louis de Broglie of Paris, a member of the United States National Academy of Science.

The year 1958 found membership in the Academy reduced to fifty-five scientists from twenty-one nations. In addressing a group of American Fulbright scholars in February of that year His Holiness spoke of the Church and science in these words:

> . . . Faith does not fear Reason; dogma is not afraid of scientific research. No indeed, the church, friend and champion of all truth, clamps no chains on freedom honestly seeking to discover the truth still hidden in nature's secrets. Rather, all such progress is dear to her heart; she encourages it,

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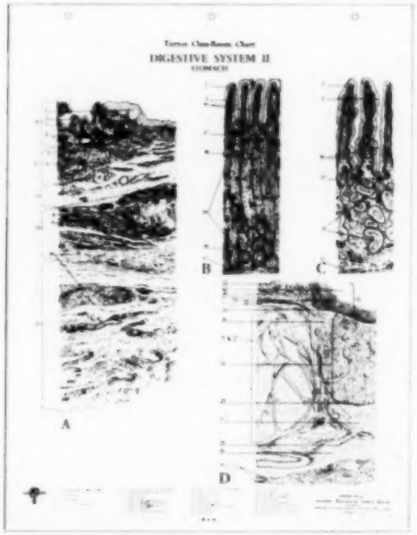

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AO Reports on Teaching with the Microscope

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Without question the microscope and the camera have a certain natural affinity for one another. Everyone, it seems, who has ever looked through a microscope and used a camera has had the desire to apply the one to the other and photograph the invisible detail revealed to his eye.

American Optical profits in a small way from this affinity, manufacturing a truly excellent photomicrographic camera at a most reasonable price. Your request for the $300.00 plus required for one of these precise research instruments would get short shrift, however, from your school administrators. So, without fear of losing business, we can proceed to outline our little plan for a very rudimentary, do-it-yourself photomicrographic camera set-up that would be entirely adequate for preliminary student excursions into the art of photomicrography.

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Our photomicrographic set-up will consist of an ordinary box camera for holding the film and a cardboard box arrangement for focusing. Any old clunker of a box camera will do . . . just make sure it has a setting for time exposure.

CONSTRUCTING ADAPTERS:

Construct two cardboard adapters, one inch high out of stiff cardboard (1/16" approx.) and model airplane cement (see fig. 1). Holes should be cut to fit snugly over microscope eyepiece.

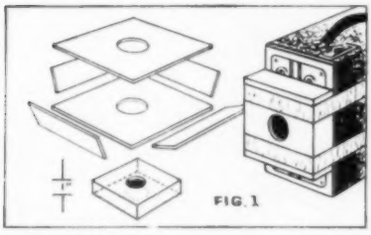

FIG. 1

PROCEDURE FOR ADAPTING CAMERA:

Remove lens from camera, (reflecting surfaces of the camera lens will produce glare, or "hot spots" on film). Tape one adapter to camera, (see fig. 1). Load camera with standard panchromatic roll film.

PROCEDURE FOR CONSTRUCTING FOCUSING DEVICE:

Construct eight inch high cardboard viewer by cementing three sides around second adapter (see fig. 2). After three sides are cemented, mount ground glass (ground side down) to cardboard shelf and then cement on fourth side.

NOTE: Ground glass *must be* same distance from face of adapter on viewer as film plane of camera is from face of its adapter (see fig. 2).

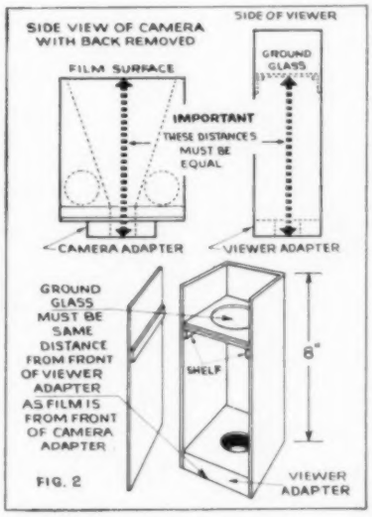

FIG. 2

PROCEDURE FOR TAKING PHOTOMICROGRAPHS:

1. Focus specimen under microscope. Be certain that the field is brightly and evenly illuminated. Then place focusing device over the eyepiece and focus microscope until image is as sharply defined as possible on the ground glass.

2. Turn *off* substage illuminator, or interpose black, opaque paper between light source and substage. Replace focusing device with camera. Set camera to time exposure and open shutter.

3. Turn *on* substage illuminator or remove black opaque paper . . . this will expose the film. After proper exposure, turn *off* substage illuminator or reintroduce black paper. Close shutter before removing camera. The camera shutter is used *only* to make the camera lightproof when it is not in use. Do not use shutter to expose film. The tripping of the shutter would create a tremor resulting in a blurred photograph. Also, be careful not to set up any other vibrations that will shake camera during exposure.

This do-it-yourself photomicrographic set-up is very convenient and very adequate. It's always ready and no elaborate adjustments are necessary.

NOTE: The following notes on microscopes, illumination and exposure are offered as guides.

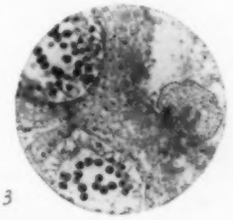
Fig. 3

A. MICROSCOPE: The microscope should be equipped with achromatic objectives and preferably, though not essential, an iris diaphragm and condenser. The AO Spencer 66 series student microscope provides just the ticket . . . its rugged, dependable and has the same mechanical and optical precision found in laboratory microscopes. If your lab already has number 66's you're all set to go ahead with your camera set-up. If not, you may want some information. Just write to American Optical Company, Instrument Division, Dept. 0237, Buffalo 15, N. Y., and ask for brochure SBTI.

B. ILLUMINATION: A substage attached illuminator will guarantee the evenly illuminated field necessary for good photographs . . . the negative will show up uneveness even where the eye will fail to notice it. Here, we are using the AO Spencer 66B Microscope equipped with the low-cost 616 attachable substage illuminator.

C. EXPOSURE: Exposure is a matter of experience. If you use the microscope-illuminator set described above, you can use the following information as a guide. The Photomicrograph (see fig. 3), was taken at 100X magnification (10X eyepiece, 10X objective) with three second exposure using Kodak Verichrome Pan film. Our trials showed that one to three second exposures yielded good results. For other magnifications you can use the following rule of thumb as a guide.

1. 430X magnification (10X eyepiece, 43X objective). Expose 4 times as long as 100X.
2. 970X magnification (10X eyepiece, 97X oil immersion objective). Expose 2 times as long as 430X.

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and is always quick to use its results, that may help her in her divine mission to bring the knowledge and love of God to men of every continent and clime[10].

When speaking to the Pontifical Academy of Sciences at a Study Week meeting held in April of 1955 His Holiness Pope Pius XII exhorted the group in words which might well have been addressed to all scientists of the world, particularly to those of the Catholic faith:

> Authorized interpreters of nature, be you also the teachers who explain to their brothers the wonders which are unfolded in the universe, and which you, better than others, see assembled as in a single book. Indeed, the majority of men can scarcely devote themselves to the contemplation of nature. They deduce from the facts they perceive only superficial impressions. Become, you who interpret creation, teachers eager to reveal its beauty, its power and its perfection so that they may be enjoyed by others.
>
> Teach others to behold, to understand and to love the created world so that the admiration of splendor so sublime may cause the knee to bend and invite the minds of men to adoration . . . You have in your hands a powerful instrument with which to do good. Take into account the unutterable happiness that you procure for others when you disclose to them the mysteries of nature and bring them to understand its harmonious secrets. The hearts and the gaze of those who listen to you are, as it were, hanging on your every word, ready to chant a hymn of praise and thanksgiving[11].

These tremendously encouraging words of exhortation from Our Holy Father Pope Pius XII are deserving of our thoughtful consideration and are sincerely to be treasured. His pointed attention to the activities of the Pontifical Academy is convincing evidence of its living, dynamic role in this turbulent atomic age. ●

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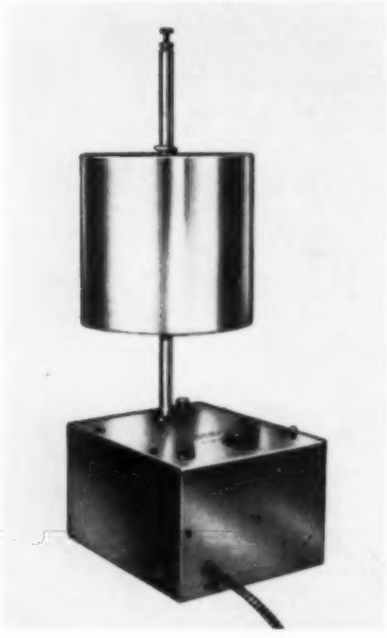

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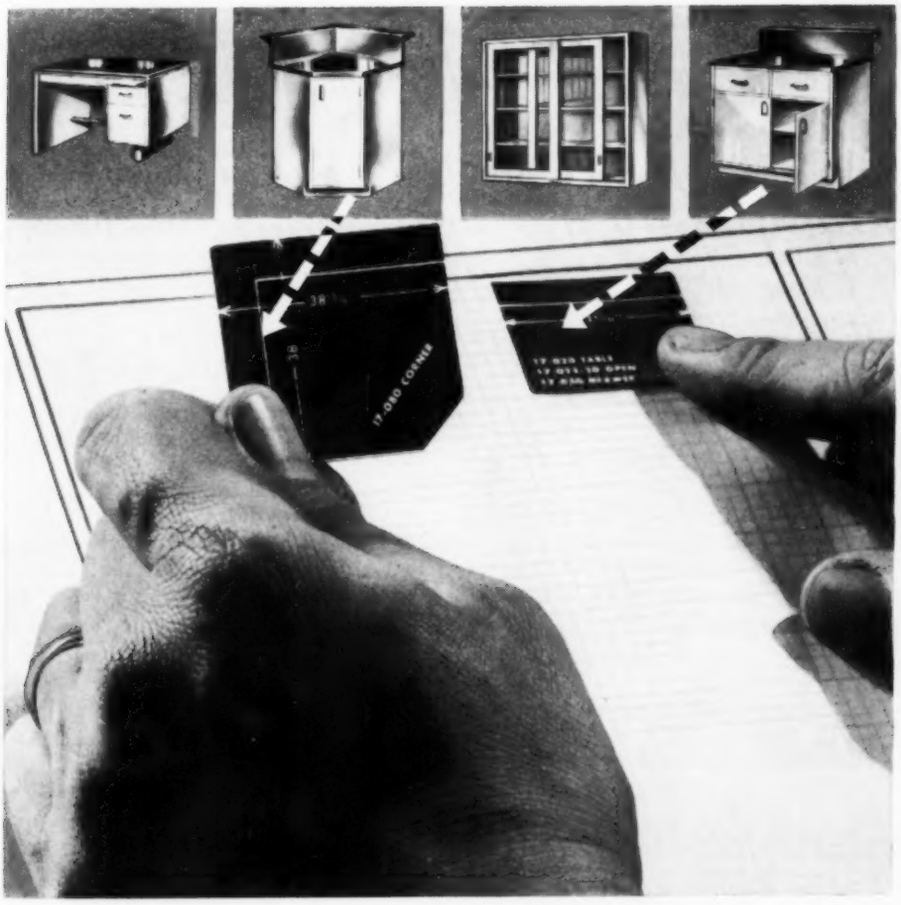

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Automatic Analysis

(Continued from Page 13)

as taken from classical chemical methods. A countercurrent dialysis system allows dialyzable components to be passed on free from interfering colloids. Eventually a color is developed in each slug of sample which is separated from the next by a slug of air. A recording filter photometer makes a permanent record of the color developed and the color is a measure of the determinate. Calibration is readily carried out with known samples which are readily placed at intervals among the unknowns if desired.

The present status of automatic analysis is then that a wide variety of analytical methods both physical and chemical have indeed already been highly automated or robotized. If by complete automatization it is meant that the apparatus not only measures and records but also takes its own samples some automatic analyzers are already complete and others could readily be made so.

What has been presented to describe the present status of automatic analysis serves readily as a guide for predicting future developments. Surely complete automatization in the sense already noted will develop. As in the case of the electrolytic moisture apparatus old principles and new materials will be brought together. As new methods such as radioactivity and nuclear magnetic resonance appear their advantages for analysis will be exploited in automatic apparatus. Where a high degree of sophistication, judgment and experience needs to be provided progress will be more expensive and less rapid. Since more than one type of analysis is often needed on the same sample trains of analyzers starting with nondestructive and ending with destructive methods will appear with robot transfer from one analyzer to the next. In short it will not be long before humans are relegated to their proper laboratory function—thinking. ●

★ ★ ★ ★ ★

Use of Spectral Absorption

(Continued from Page 6)

Summary

Generally vibration spectra are applied to organic molecules since they permit a determination of possible functional groups and thus serve either as a guide to regular chemical confirmation, or they may serve as a confirmation to chemical analysis. Since the method requires only trace amounts of material and is rapid,

THE SKY IS THE LIMIT

The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age." Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.
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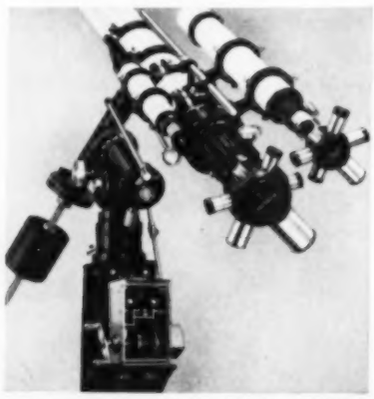

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it is widely used in all research laboratories—both industrial and academic. In the analysis presented involving the commonplace copper salts we come to a realization that we need beware of a too naive concept of the structures involved. We may broadly speak of replacing 4 water molecules as ligands in the hydrated copper (II) ion with 4 ammonia molecules, and the individual differences of the ligands appear in both the electronic and vibrational spectra of the resulting complex cation. Further, the structure, both as to strength of bonds and crystal form, will differ in different co-ordination compounds involving the same complex cation but different anions and this difference is most readily seen in the vibrational spectra. Thus, over the range of electromagnetic radiation possible for meaningful detection with the present laboratory instrumentation, these copper compounds are able to indicate their preferences and we can reason back from the preferences as to something of the type of substance we have probed. ●

★ ★ ★ ★ ★

Health of Plants, Animals

(Continued from Page 17)

which should range between pH 5.8 to 6.8 This may be done by suitable dietary specifications, and the use of alkaline or acid supplements as each case may call for.

Attempts to promulgate specifications for nutrients for human health "from the soil up" would prove unavailing, Just as it would be impossible to start with raw materials to construct an airplane. The design must be based on the ultimate purpose, and this concerns the final body in optimum health, its composition and needs. There are at present 160 centenarians in America on social security, out of an estimated total of 3,000 in this country. A study of their nutritional and genetic backgrounds may be used as a guide, and then compared with the dietary habits, etc. of persons who died prematurely or are diseased. If it were found that the centenarians abstained from eating highly processed, refined foods it would confirm the opinion held by many authorities that the over refining and carbohydrate concentrations of modern diets is primarily responsible for the prevailing chronic disorders, and malnutrition generally. At any rate it would seem that specifications for good health require knowledge of the composition of bodies that are diseased in comparison with bodies in good health, and a study how to supply the difference.

Until biology becomes a matter of specifications along the principles of an exact science which indeed it is, the field of nutritionists is likely to be confined to balancing soil life for the benefit of crops; plant life for the benefit of the herbivora, foodstuffs, from sources that are immaterial, for the benefit of the omnivora which includes humans. This leaves a predatory existence for the carnivora. Nothing is ever naturally in balance for optimum effects. Soil amendments, feed and food supplements make balancing pos-

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sible. The uniqueness of man lies in his ability to either improve his physical and mental qualifications through nutrition, or to let them deteriorate through the selection of foods for reasons other than his health. Not only foods but all matter consist of about 100 known atoms. Their course may be followed from time of ingestion or inhalation by the body into their final complexities and decomposition, an undertaking up to man himself. ●

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★ ★ ★ ★ ★

The Neglected Factor

In the midst of the present day emphasis on science in high schools, we are neglecting one of the fundamentals of any education program . . . the role of human vision, according to Fred W. Jobe, Director of Ophthalmic Research at the Bausch & Lomb Optical Co., Rochester, New York.

Eyesight is one of the basic essentials in a society dominated by technological progress and scientific skills. Yet in spite of the current attempt of educators and industrial leaders to create interest in science careers among the boys and girls of high school age, and to raise the academic standards generally, too little attention is being given to making sure that today's youth has the proper vision for maximum learning.

"More than 80% of all we learn reaches us by way of our eyes; the balance being acquired through our other senses—hearing, tasting, touching and the sense of smell," says Jobe. "At the same time that we accept the importance of vision to learning, we are faced with

the fact that three out of every ten children in our elementary schools and high schools are handicapped by inadequate vision."

He made a point of stating that many of these cases are not serious, since the visual efficiency of these young people is only slightly impaired and can be corrected by simple means that are at the disposal of the ophthalmic professions. However, he emphasized that in a nation like ours, which is so conditioned by technological progress, adequate vision is of the utmost importance. The written word, the text book, lab reports, the charts and diagrams, the engineering blueprints are fundamental to a secure, scientific knowledge. Today our young people are being required to use their eyes more than has ever been necessary in the past.

He went on to say, "If we stop to consider the thirty per cent with faulty vision, the three hundred out of every thousand young people whose ability to learn is impaired by an inability to see properly, we are aware at once of a weak point in our attempt to provide this country with the best trained scientific and technical minds.

"There is no necessary correlation between good vision and potential intelligence. Many young people who might show ability are not doing their best because they cannot see clearly, or because eye strain soon causes fatigue and consequently a disinterest in or even antagonism towards their work. Somewhere in this thirty per cent of the youth of today we are 'mislaying' a considerable number of young men and women who should be trained in the scientific and technological skills necessary to maintaining the strength of this country as the leading world power."

Jobe emphasized the fact that the real tragedy which underlies this problem is that most of it can easily be avoided. He cited a recent article in the *New York State Journal of Medicine*, which pointed out that "the majority of visual problems are amendable to correction by spectacles. If all children with refractive errors were given examinations, it would be possible to improve visual ability or comfort in at least 90%."

Jobe went on to say that a great deal of progress has been made in treating even the most complicated vision problems and prescribing correction eyewear. Modern, scientifically accurate instruments for testing young people's vision are being introduced on an ever-increasing scale in primary and secondary schools throughout the country. Education officials and members of the ophthalmic professions are cooperating on effective eye-care programs for the school-age group.

"But, in spite of this," Jobe pointed out, "not enough people have been made aware of the essential requirements of proper vision for a nation in which people with technological skills and professional training in the various fields of science are in such great demand.

"Parents have the greatest responsibility of all in seeing that their children have had thorough, professional eye examinations and have been fitted to eyeglasses when examinations have shown this to be necessary." ●

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New Books

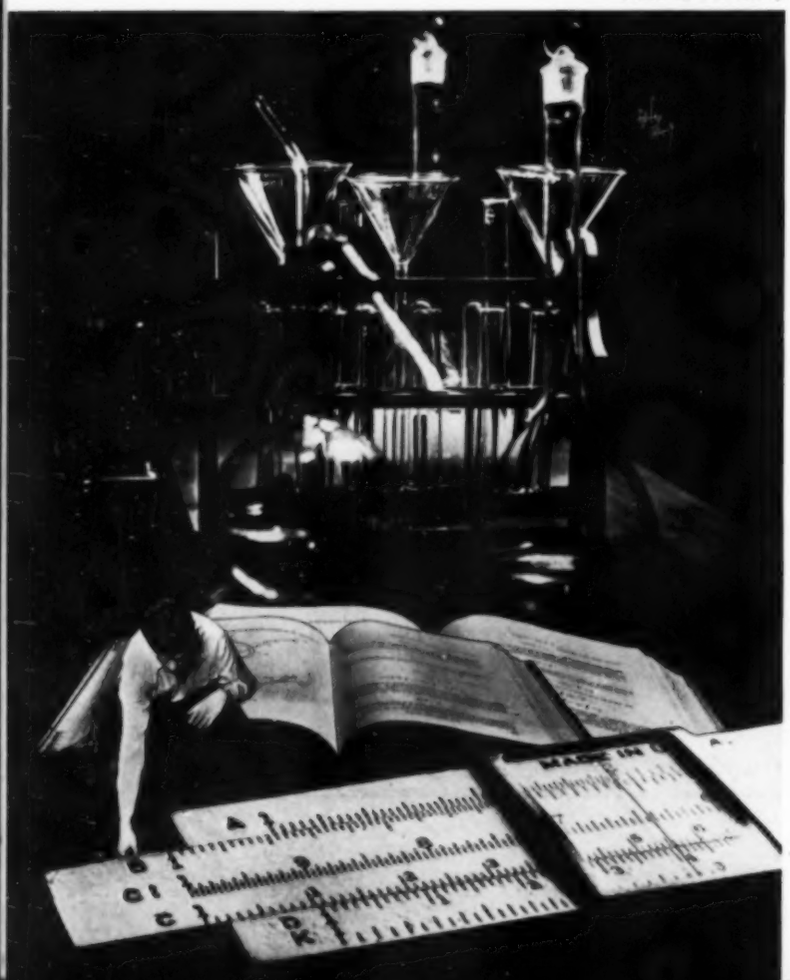
Education And Freedom

• *By* VICE ADMIRAL H. G. RICKOVER, U.S.N.
E. P. Dutton and Company. New York.
Pp. 256. $3.50.

To the many people who are sincerely concerned with the status of American education, Admiral Rickover's "Education and Freedom" will be eagerly read and debated. Most of us did not have the opportunity to hear the addresses of Admiral Rickover. We were, thereby, forced to evaluate him on the basis of journalistic reporting. Since this book is a warmed-over treatment of his addresses, we have primary source material to analyze.

The thesis is not new in educational circles. It has been debated and partly agreed upon by such divergent groups as Robert Hutchins and Mortimer Adler, and by the Essentialists in American Education. In truth, anyone who has opposed John Dewey and the Progressivists, has had feelings akin to the author's in regard to the direction we have been following in American schools.

The prophetic flavor and messianic mission that pervade the book will attract many followers. Essentially it would have us do away with comprehensive high schools; abandon life adjustment programs and all they stand for; adopt the traditional European system of Education—even the Russian, if necessary—without, of course, the Russian objectives; return the school to the laymen; raise the salary and dignity of the teacher; and, at the same time, do away with the professional courses which have established educators as professional persons.

Photo by Vic Kelley

While one can agree with the bleak picture that is presented regarding the future of America if we continue to exhaust our natural resources, one can hardly place the entire blame on John Dewey and his Progressivists, despite the damage their thinking may have caused. Frankly, that is giving too much credit to Dewey and Columbia University, and to the now defunct Progressive Education Association.

The constant comparison between the traditional European secondary system and the achievements of the aristocratic students with the comprehensive American school system and the American students' failure to achieve is certainly a weak, but necessary one for professional analysis. The average American not long advanced from peasantry does not have the same educational ideals and objectives as his aristocratic overlords in European countries. That we now need them, no one will doubt. The question is: How can these be forced upon him in a democratic society? These addresses do not mention the inadequate professional preparation — even in subject matters — with which European elementary school teachers were prepared.

As always with one who concentrates on destructive criticism, extremes are avidly presented as averages. In lambasting Doctors of Education, and their dissertations, the author does not recognize the many Professors of Education with traditional preparatory school backgrounds, Liberal Arts undergraduate and graduate degrees, and, above all, an inside knowledge of the problems of teaching which comes from long years of experience at all levels in American education. Most of these people are more keenly aware of the situation than Rickover would have us believe. Not only are they aware of it, but they are constantly struggling to improve it.

The sad commentary on this entire situation is that even our private schools—not progressive—do not produce University graduates who satisfy the Admiral's requirements. Yet, it is quite certain that most of his Colleagues were graduates of the very kind of school which he advocates.

Finally, his return to a teaching method based on faculty psychology is analogous to curing the mentally disturbed by the cold water shock treatment or the isolation ward. His disapproval of the organismic concept would cause us to retreat to the Pavlov "forced-cue" theory in learning. Under such theories and methods, where can we point to the free American?

We wish as eagerly as Admiral Rickover to see our students pursue a more intensive liberal arts and humanistic program of education. We hope with him that teachers' salaries and prestige are increased. But, above all, we pray that the culture which deters teachers from teaching and coddles the child, will realize the basic philosophy of education. It is the parent's responsibility to see that his child is properly educated: the teacher is in loco parentis. With the parent's help, teachers will satisfy the demands of "Education and Freedom." Dr. Conant has shown us a way, but Dr. Conant is an educator.

H. F. McGinn, Ed.D.
School of Education
Duquesne University

Elements Of The Universe

• *By* GLENN T. SEABORG and EVANS G. VALENS. E. P. Dutton and Company, Inc. New York. 1958. Pp. 253. $3.95.

It is unfortunate that our leading scientists do not have the time to prepare popular books on science for younger readers. Literature of this kind would be of great value in encouraging young students to seek a career in science. *Elements of the Universe,* co-authored by a Nobel Prize winner, clearly written, and attractively printed and illustrated is such a book.

While the book is written for youngsters, its content is so modern and its presentation so clear, that it can be recommended to the general reader. It covers the development of chemistry from alchemy to Element 102. While the coverage is not as comprehensive as the mature reader would like, it is still an enjoyable book to read.

We recommend this book to every school librarian and science teacher.

J. P. M.

Dictionary Of Astronomy And Astronautics

• *By* ARMAND SPITZ and FRANK GAYNOR. Philosophical Library, Inc. New York. 1959. Pp. 459. $6.00.

The general reader, whose knowledge of the technical terms of space science is limited, will find the *Dictionary of Astronomy and Astronautics* to be an excellent handy reference. It contains the definitions of all the new and old words in the field.

The definitions are clear and concise, many could be helped by the use of diagrams. Unfortunately except for 16 excellent full-page plates bound into the center of the book, there are no illustrations. Many definitions could be omitted without loss of the book's value; the classic being the definition of a second as a sixtieth part of a minute. In general the definitions are good and well cross-referenced.

The authors are well qualified on their subject. Armand Spitz is the coordinator of visual satellite observations for the Smithsonian Astrophysical Observatory, and Frank Gaynor is a contributing editor of the *Encyclopedia Britannica.*

It's Your Life

• *By* J. J. CRIBBIN, BROTHER PHILIP, O.S.F., REV. W. J. MCMAHON. Harcourt, Brace and Company. New York. 1957.

This is the third book of the *Insight Series,* a series of books designed to provide the Catholic secondary teacher with tools to conduct a group-guidance program.

It's Your Life is an excellent textbook for a homeroom program or guidance course. It discusses the attitude that students should have towards life, encourages serious thinking, and discussion on their attitudes, vocation, and future education and training, the question of going on to college, college entrance requirements, choice of the college to attend and other types of information a student planning to attend college will need. The student who will not go to college is not forgotten and there is an excellent discussion of service in the armed forces, education in service

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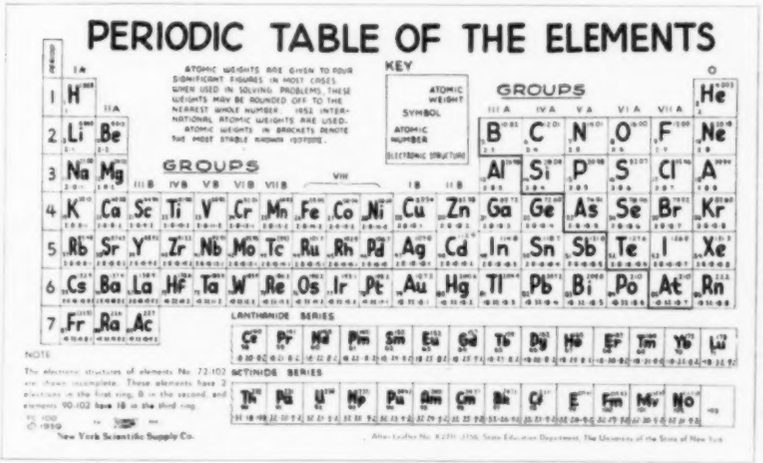

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Adventures In Science

• *By* W. J. JACKOBSON, R. N. KING and L. E. KILLIE. American Book Company, New York. 1959. Pp. 387. $3.56.

This is the seventh grade book of the *ABC Science Series: Science in Our Changing World.* It is completely modern in content, pedagogically sound and attractively printed and illustrated.

The text is divided into six units, the solar system and the universe, our soil, weather, electricity, food and nutrition, and living things. Each unit is well organized, and at the end of each chapter, a summary, vocabulary review, discussion questions, suggestions for experiments, and a reading list are presented. The plan is such that both the ordinary and the exceptional student will find it challenging.

Science teachers who are planning a change of textbook or who are dissatisfied with their present text should examine this excellent book.

Mainsprings Of Civilization

• *By* ELLSWORTH HUNTINGTON. New York. *A Mentor Book.* New American Library of World Literature, Inc. 1959. Pp. XII + 669. $0.75 (Paper Back).

This is a reprint of a controversial book originally published in 1945. It is still just as controversial and as up-to-date as it was in the hard-cover edition.

The development of the character of a nation is explained in terms of the physical and cultural inheritance of its people, geography, climate, and the vigor and innate ability of its people. It is a scholarly presentation of the facts of geography, science, and history. However, the interpretation of the significance of the facts presented is deterministic, and the usual tendency to apply the methods of science to matters outside the scope of science will cause many serious differences of opinion. The influence of hereditary selections, geography, and climate on the character of a people is undoubtedly great, but they are not the only, nor the principal factors. The possibility of revelation is not even mentioned in discussing religion, and an attempt is made to correlate religious beliefs to climatic geographical and other physical characteristics of a kith (a group of people relatively homogeneous in language and culture and freely intermarrying).

This is a book which should be carefully read by every serious and mature student of science, sociology, history, and philosophy.

J. P. M.

Teaching Science To The Ordinary Pupil

• *By* K. LAYBOURN and C. H. BAILEY. Philosophical Library, Inc. New York. 1957.

In 1950, a committee was set up in Manchester, England to consider the content of science for secondary schools. The committee centered its attention on the ordinary pupil and laid down the following principles: (1) The pupil's own experience should be the main guide. (2) The subject matter should deal primarily with objects and only secondarily with principles. (3) A very wide treatment is desirable, extending over the conventional subject boundaries. (4) The content must be such as will provide ample training in looking carefully at objects and events in dealing with practical situations.

The authors have fulfilled the directions of the committee and the result is an excellent book for both the experienced and the starting teacher. While it does not follow our customary breakdown of courses, it will be a useful addition to the library of any teacher. Experiments on the air, burning, structure of plants and animals, food, water, electricity are attractively described. There is no need for expensive or specialized equipment, any typical high school laboratory will have the equipment needed or can obtain it at a very moderate cost. Excellent illustrations add to the appearance of the book and also clarify the text.

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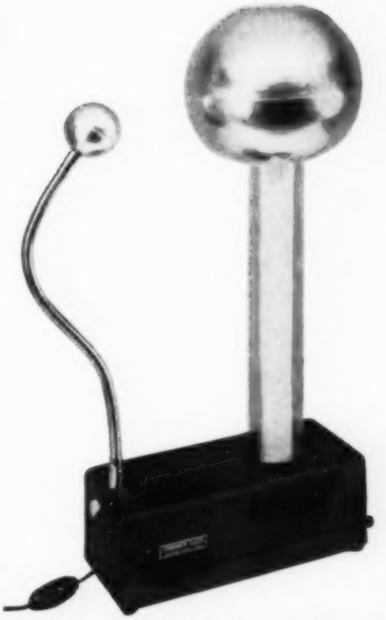

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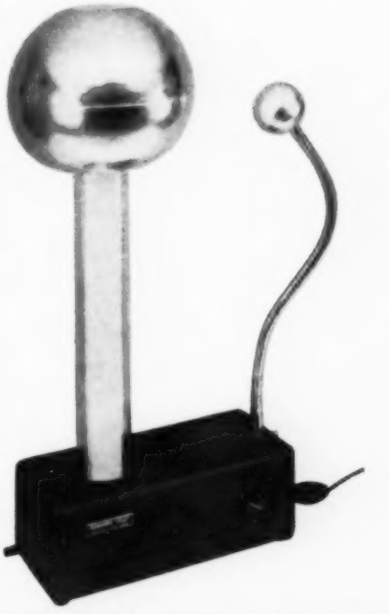

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